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AN IMPROVEMENT IN THE AMALGAMATION AND EXTRACTION OF GOLD FROM ORES.

A RAPID alternating current of electricity is applied in a recent improvement by W. Crookes to the amalgamation and extraction of gold from refractory and other ores; this process well deserves some notice in these columns.

The present method of extracting gold from refractory ores, such as the sulphides, tellurides, arsenio-sulphides, &c., of zinc, copper, bismuth, antimony, iron, &c., by the method of amalgamation with mercury is well known to be very imperfect. This is due to the fact that the sulphides, arsenio-sulphides, and other minerals which may be present in the ore cause the mercury to "flour" and "sicken," as it is technically termed. The result of the "flouring" and "sickening" is that the mercury loses to some extent its natural fluidity, and if the process be pushed to the limit, the mercury either becomes powdery or else settles down into a tough tenacious mass, in which condition its value for amalgamating purposes is greatly impaired; in fact, its amalgamating action may be entirely destroyed.

It is calculated that from 30 to 80 per cent. of the gold may escape the action of the mercury if the latter "sickens" or "flours." This is the more to be regretted, because under the most favourable conditions, even when the mercury retains its active fluid state, it will seldom take up more than one-half or two-thirds of the gold that may be present in the ore which is under treatment, owing to the coat of tarnish which almost invariably covers the particles of the precious metal. The coating of tarnish can only be removed chemically or mechanically; in the latter case long grinding is necessary, and this process tends to "flour" the mercury.

There is another common method of extracting gold which consists in roasting the raw ores until all the sulphur which they contain is expelled; they are then treated with chlorine gas or with a liquid which is a solvent for gold, after which the metal is precipitated from solution by suitable means. This process is evidently a purely chemical one, and it is well known to be very expensive.

The improvements introduced by W. Crookes consist in treating the ores with a solution of cyanide of mercury or some other soluble salt of mercury, *e.g.*, the sulphate. Such treatment removes the film of tarnish and causes a slight superficial amalgamation to take place on the surface of the particles of gold.

The proportions of cyanide in the solution may vary according to circumstances, but usually the solution is made up as follows:—

Solution.

Cyanide of mercury	2—3 lbs.
Water	80—100 gallons.

This is sufficient, as a rule, for the treatment of 1 ton of raw ore.

When the solvent action of the cyanide is complete the solution may be drawn off from the ore, and the latter is then treated in amalgamating pans in the usual way.

Heating will accelerate the action of the cyanide solution.

This process may be vastly improved if the current from an alternating dynamo machine be available.

The auriferous ore, "tailings," sulphuret, &c., are first ground to a fine powder, and then well mixed with a solution of any cheap mercury salt that will dissolve easily. A rapidly alternating current of electricity is now passed into the pasty mass, which may be well agitated, or may remain at rest.

The bulk of the mass is not a very good conductor of electricity, while the fine particles of gold that are sparsely disseminated through the mass are of course excellent conductors. The equi-potential lines of force will converge towards these particles, with the result that more of the electric current passes through them than through the rest of the mass.

The two sides of each particle of gold will act alternately as anode and cathode. On one side, which may be the anode for the time being, sulphuric acid (if mercuric sulphate be the salt of mercury employed) is liberated, and on the

other side of the particle, which will be the cathode for the time being, metallic mercury is liberated; but the affinity of gold for mercury is so great that the two metals instantly unite and the gold becomes amalgamated.

At the next alternation of the current, the side of the particle of gold which had the sulphuric acid liberated on it now has the mercury precipitated on it and *vice versâ*. The mercury, instead of recombining with the sulphuric acid as under ordinary circumstances it would do, again attacks the gold by reason of the stronger chemical affinity, and thus each alternation leads to a liberation of mercury on the surfaces of the particles of gold.

By this process the finest particles of gold, known technically as "float" and "flour" gold, are amalgamated, and the coarseness of the ore makes no difference to the efficient performance of this operation. Amalgamation will take place as long as the solution is able to penetrate to the particles which are hidden away in the matrix of ore.

The use of the alternating current is claimed to possess a further advantage in so far as it succeeds in heating the mass: this heating is due to the sudden and violent decompositions and recompositions that take place, and it facilitates the progress of the amalgamation.

It is stated that the mercurial salt may also be used to advantage either with or without the electric current in the grinding and amalgamating apparatus, so that the cleansing of the particles of gold from the film of tarnish that is on them and the amalgamation go on simultaneously; it may also be used in concentrating and vanning machines.

THE MOST ECONOMICAL RATE OF WORKING FOR INCANDESCENT LAMPS.

THE question of what is the best rate in watts per candle-power at which to work an incandescent lamp has lately been the subject of several papers and articles which have appeared in the REVIEW; and we now see that it is attracting attention on the Continent, as an article on the same subject by M. Simon is published in a recent issue of *L'Electricien*, in which the author shows a graphical method of determining the most economical efficiency for the lamp under various conditions of working. The method consists in determining the cost per lamp-hour of three values, namely, the interest and depreciation on the installation exclusive of the lamps, the price of the electrical energy, and the cost of lamp renewals; and in plotting the values of each as curves with the different rates of watts per candle-hour as abscissæ, and expenditure as ordinates. By graphically summing the ordinates of the three curves, M. Simon obtains a fourth curve representing the total expenditure per lamp-hour, and from this he determines the best rate at which to work the lamps. Three cases are considered, in the first the supply is obtained from a central station; in the second from a dynamo on the premises driven by an existing steam plant, as might be the case in a factory; and in the third by a complete generating plant specially put down for the purpose. The interest and depreciation on the plant is left out of account in the first case, as it is assumed that it will be constant for lamps taking from 2 to 4 watts per candle; in the second case it is represented by a curve whose ordinates increase from about one-third of a centime per hour for a 10-candle lamp at 2 watts per candle to half a centime for a similar lamp requiring 4 watts per candle; and in the third case, where the complete generating plant is included, by a curve whose ordinates are respectively 0·68, 0·88, and 1·04 centimes per hour for a 10-candle lamp at 2, 3, and 4 watts per candle. The cost of electrical energy when supplied from a central station is given as 1·25 francs per kilowatt-hour, which is high as compared with the prices ruling in England, and as 20 centimes per kilowatt-hour when the factory engine is used. In both cases the curve is plotted as a straight line, the watts required by the lamp being taken as the same throughout its life. In the third case, where the labour has to be specially provided and may be taken at a constant cost, the price per kilowatt-hour is less for the larger outputs, being 60, 45, and 38 centimes respectively, when lamps of 2, 3, and 4 watts per candle are used.

The cost of lamp renewals is of course the same for each of the three cases, and as this is the item of the total expenditure about which there exists the greatest uncertainty, we think it may be of interest to go more fully into the data on which M. Simon bases his figures. The author refers to the results obtained in America by Mr. Pierce and Prof. Nichols, as showing that a higher initial efficiency is accompanied by a more rapid falling off of luminous power when lamps are compared hour by hour. He proposes, however, to compare the various lamps in a somewhat different manner, which is to plot curves in which the ordinates represent luminous power and the abscissæ the time—not in hours—but as a fraction of the total available life of the lamp; and he points out that in this way it is possible to arrange that the average candle-power of the various lamps shall be the same, no matter what value is assigned to the ratio of initial watts to initial candle-power. Working on these lines he made observations on a series of lamps with the following results:—To obtain the same average candle-power, which was, we understand, about two-thirds of the initial, he found that a 2-watt lamp should be burnt for 130 hours, a 2½-watt lamp for 300, a 3-watt lamp for 600, a 3½-watt lamp for 1,000, and a 4-watt lamp for 1,500 hours. From these figures he calculates the cost of renewals per lamp hour taking 3 francs as the price of the lamp. The objection to this way of making the comparison is that the result will vary very much according to the value assigned to the average candle-power, because no account is taken of the most economical life of each type of lamp; and this life, as was shown in an article published in the ELECTRICAL REVIEW of the 8th May, varies with different costs of power and of lamp renewals. For example, if power is cheap enough to make it economical to burn a 4-watt lamp for 1,500 hours before renewing it, then it will probably be found that 600 hours is much too short a time to burn a 3-watt lamp; and, on the other hand, if power costs so much that it pays to throw away the 3-watt lamp after 600 hours, then it will not pay to burn the 4-watt lamp for as long as 1,500 hours. Of course, it is impossible to say exactly how the figures would come out, without knowing the curves given by the lamps on which M. Simon bases his calculations; but we should expect to find that the economical rate of working would be higher than is given by his method for dear power, and lower for cheap power.

The whole question appears to be a difficult one to deal with, as each writer on this subject takes a different view of what is to be aimed at; one taking as his goal the smallest cost at which a lamp of a certain rated candle-power can be maintained, irrespective of the actual amount of light given by the lamp at different periods of its life; another bases his calculations on the idea that the life of each type of lamp should be regulated in such a manner that the cost per candle-power hour shall be a minimum, which may mean that the average candle-power of lamps of different efficiencies will be unequal; whilst a third considers that the life of each type of lamp should be arranged in such a manner that all give the same average candle-power. None of these methods can include the effects of all the varying quantities which are found in an incandescent lamp; but it is probable that either the second or third will give sufficiently accurate results for all practical purposes, and it is therefore desirable that tests should be made on lamps of different manufactures, so that the necessary data for making the calculations in either way may be to hand. M. Simon refers to a series of tests which have been made by M. Bainville, the results of which are to be published shortly; and we hope that these tests will be sufficiently complete to clear up many of the doubtful points, which render it difficult to decide at present on the best efficiency for incandescent lamps under various conditions of working.

The results obtained by M. Simon are that for a supply from a central station at 1·25 francs per kilowatt-hour the lamps should be worked at an initial rate of 2½ watts per candle; for a plant on the premises, but driven from the factory engine, the rate should be 3·5 watts per candle, and for a complete special plant the rate should be 3·3 watts per candle. A curve is also given showing how the initial efficiency varies for different costs per kilowatt-hour, which gives an efficiency of 2½ watts when power costs 1·25 francs, of 3 watts when it costs 66 centimes, of 3½ watts when it costs 30 centimes, and of 4 watts when it costs 15 centimes per kilowatt-hour. If these figures were adopted by the consumers as a guide in choosing their lamps, it would practically abolish all lamps requiring more than 3 watts per candle, a result which would possibly not be welcomed by the supply companies, as although it would enable them with their present plant to supply a larger number of customers, it would also mean a larger area to be covered by the mains, and therefore an increase of expenditure on them for the same output from the station.

ELECTRIC LIGHTING IN THE CITY OF LONDON.

THE prospectus of the City of London Electric Lighting Company, Limited, has been issued, with a share capital of £800,000, and power to issue £400,000 of debentures. The subscription list opened on the 15th inst. and closed the following day, a proceeding which indicates that the taking up of the bulk of the stock had been pre-arranged. This fact will probably send the shares up to a premium, since the time allowed was too short for the public generally to come in, but this will doubtless be immediately followed by a lull, and eventually a downward tendency will bring them to their proper level, for a considerable time must elapse before anything is shown for money spent.

The Board seems composed of men whose *bonâ fides* are above suspicion, but from a business point of view we should gladly have seen it stronger. To us it is strange to see that Sir David Salomons has consented to act as chairman, for he has hitherto, we believe, had a rooted antipathy to having his name connected with company transactions. We are perfectly sure, however, that with Sir David at the head of the directorate, the shareholders can but feel that their interests will be faithfully and conscientiously served, but as Sir David has the reputation of being the first amateur expert in the three kingdoms on all questions connected with electric lighting, we are all the more surprised that he should have allowed the company's prospectus to be launched in its present guise.

The company is formed to finance the important contracts which, under provisional orders, have been entered into by the Laing, Wharton and Down Construction Syndicate and the Brush Electrical Engineering Company.

The company will begin operations with an ordinary share capital of £400,000, and power to issue hereafter a further sum of £800,000 in preference shares and debentures. The companies mentioned as owning the rights are not to receive any direct payment for those rights, but they are to carry out the work of completing the generating plant and equipping the central stations for the service of the three districts for the following amounts:—Eastern, £196,250; Western, £139,000; and Central, £158,000; making a total of £493,250, which is certified by General Webber, the chief engineer to the new company, to be a fair and reasonable sum. A pioneer company, which was formed in February last with a paid-up capital of £50,000, and which has spent a considerable sum in executing part of the contract work, has also to be bought out, and the cost of laying underground conductors, purchasing sites, and erecting buildings will have to be met. The total estimated expenditure for freehold land, buildings, generating and distributing plant, and sufficient mains and conductors to provide for the installation of 400,000 private lights of 8 candle-power, as well as for the whole of the public lighting (from which a revenue of £21,000 per annum is ultimately expected), and for the requirements of the district of St. Saviour's, Southwark (for the lighting of which the Brush Company has also a provisional order), is £1,050,000; so that the capital of £1,200,000 resulting from the present issue and from subsequent issues of preference shares and debentures is believed to be ample to meet all the requirements of the company.

Says a financial contemporary: "Let us see what are the chances of such an undertaking turning out a profitable investment?" The city paper then goes on to make comparisons between the St. James's and Pall Mall Company, the Berlin Electricity Works Company, and the experiences of New York, and argues from favourable published statistics that the City of London lighting must likewise be a grand commercial success. The St. James's and Pall Mall Company, which had only 12,000 lights in September, 1890, had 33,000 lights in June, 1891. It has lately declared a dividend at the rate of 7 per cent. per annum, and its £5 shares are now quoted at 7 to 7¼. It must be recollected, however,

that this company operates in a district which, residentially, may be termed the cream of London. Here we have theatres, clubs, mansions, all burning electric lamps into the small hours of the night. In Berlin, also, shops, restaurants, and places of amusement remaining open long into the night make the item of lamp hours a heavy one; but in the City of London the circumstances are quite different.

Banks close in the afternoon; restaurants, except in a few instances, do not keep open doors far into the evening, shops are shut comparatively early, and warehouses earlier still; indeed, so far as business is concerned, the City is only in evidence during the daytime. The comparison, then, between the data of a West End Clubland and residential district, of a a foreign town quite unlike our city, and the future prospects of the company just brought out is one of a purely hypothetical nature and misleading in almost every respect. While in Clubland long hours of lighting obtain every day of the week, the City Company can only reckon upon five days for supplying electrical energy on a large scale; on Saturdays business is over before the darkness sets in and on Sunday the City is practically deserted; even when the City lighting is in full swing, it might almost be said that the West End companies turn on their most remunerative output at the time the City is shutting down. It is admitted that private residents take to electric lighting much more slowly than do the proprietors of business places, and so far as the City of London is concerned private house lighting need not be considered; the chances for the company, then, are purely amongst the business population and, as we have already stated the hours of lighting, or, in other words, the supply of electricity for the City requirements must of necessity be somewhat limited. There are certainly innumerable places in the City where artificial light is required all day long, but it remains to be seen whether gas will be ousted from the places it has so long served if, compared light for light, electricity is to cost between two and three times as much.

The plea advanced that the peculiar climatic conditions of London renders the use of the electric light during a large part of the year almost a necessity, and that therefore the company will have an exceptionally valuable field for its operations, is delightfully fresh, and shows an originality on the part of the compiler of the prospectus which should speedily bring him renown in other fields of action. Has not the same been thought or said of gas, and is it at all likely that where light is wanted during a large part of the year it has not already been secured in some form or another? In a vast number of places where gas is employed as *light*, and having no reference to health or the deteriorating effects of indifferent combustion upon decorations, &c., there would be no useful object gained in substituting the electric lamp, but of little truisms of this sort the promotors of the new company take no heed.

The opponents of the transformer system, which we believe will be adopted, would turn this weather question against the company, for everything must be in readiness whether climatic influences render it necessary or not, to turn on instantaneously the full output. If the vagaries of the English climate should make winter comparatively bright, the plant would be working light for many hours at a time, and it is well understood how uneconomical it is to use the transformer system except at full, or nearly full load.

The investor does not want to know how many lamps the Metropolitan Electric Supply Company has connected up since last December, nor the increase of lights since February on the circuits of the Westminster Electric Supply Corporation. The question is, what dividends have they paid? and so far as these two are concerned, surely it would have been better policy to have omitted all mention of them instead of holding them up as a dubious bait. But, as we have previously said, the taking up of shares was evidently pre-arranged privately, so, perhaps, the matter, as far as the public is concerned, is but of secondary consideration.

We do not by any means assert that electric lighting cannot be made to pay in the City district, but we do unhesitatingly object to the way in which the prospectus deals with what has been accomplished in other places, with the view of propagating the idea that similar good fortune must necessarily fall to the lot of the City Company. The public lighting of the first city in the universe should certainly be accomplished by electricity, and even commercially it might prove successful; it remains to be seen if private lighting will be so on the lines laid down. The contracts, also, which have been concluded, under the supervision of Major-General Webber, may or may not be fair and reasonable, but considering his previous connection with the Brush Company, the advice of an independent expert might have carried much greater weight, and would have been better policy.

Although we cannot agree with our financial contemporary that the company starts with the most favourable auguries of success, we trust that it will strive to do all that its most sanguine supporters hope from it.

It must be admitted, however, that the arguments advanced do not by any means carry conviction with them, and we shall in all likelihood return to this subject again, for only last week we expressed ourselves as utterly opposed to the system of placing half truths before the public.

Aluminium.

Within a few weeks the Minet process for the production of aluminium by the electrolysis of fused fluorides of sodium and aluminium, and chloride of sodium, which, during the past few years, has been experimented with at the works of MM. Bernard Brothers, at Creil, near Paris, will be worked at St. Michel (Savoie). The motive power will be supplied by a waterfall, and to commence with, two dynamos of 3,600 ampères and 50 volts each will be employed. Only 6,000 H.P. will be used, but it is proposed to increase this to 20,000 H.P. The actual cost price of aluminium by the Minet process is 3fr. 50 (2s. 11d) per kilo., not including the motive power, which can be calculated, given, as stated by M. Minet, that 1 H.P. yields 30 grammes of aluminium. The production of 1 kilo. of aluminium requires 1½ kilos of fluoride of aluminium; 100 kilos of aluminium are produced on electrolysing 150 kilos of fluoride of aluminium, 200 kilos of alumina, and 100 kilos of chloride of sodium. To prevent the corrosion of the tanks by the electrolyte, M. Minet has devised the combination of a metallic tank shunted on to the cathode through a resistance, so that there is no interruption in the electrolysis of the fluoride of aluminium, and no fluoride of the metal of which the tank is made is formed, which metal would be deposited on the cathode instead of the aluminium.

Cambridge Electric Lighting.

AT a recent meeting of the Town Council of Cambridge, on the subject of the electric lighting, it transpired that independent tests made on the new "Parsons" condensing

steam turbines and dynamos showed that these machines are more economical with regard to fuel by at least 50 per cent. than are the older forms of "Parsons" generators employed by the Newcastle and District Electric Lighting Company, which company, it may be remembered, is able to pay a dividend, despite the low charge of 6d. per unit (less a substantial discount to large consumers) that is made and the short time the station has been at work. No doubt this satisfactory result is, in some measure, due to the low prices of coal in Newcastle, but though at Cambridge the cost of coal will be somewhat greater, so also will be the price obtainable for electricity per unit, gas in Cambridge being considerably more expensive than in Newcastle. The results of the tests accord with the information which we gave in a paragraph published on June 5th, and with which an estimable contemporary was pleased to disagree. Perhaps some further fault will now be found.

The Telphone in France.

SOME time ago the Société Générale des Telephones, by virtue of a decision given in its favour by the Court of Appeal, which granted to the former the exclusive right of manufacturing telephonic apparatus provided with the Edison induction coil, caused to be seized all such apparatus in course of construction by different firms to which licenses had not been accorded. The general management of the Posts and Telegraphs then adopted the Roulez instrument. To-day the telephone company is making further attacks. Alleging that the coil used in the Roulez apparatus is comprised in the Edison patent, the company has just taken possession at the various works of all the Roulez instruments under construction. This will doubtless lead to another action at law.

Electrocution.

WE are glad to see that the *Referee* defends the law of electrical execution, and that after considerable argument it concludes that on every rational ground we have a right to suppose death by this means is painless, and that it is the merest nonsense to hint at its being the medium of untold agonies. It is complained that the executed criminals show marks of burning, but, as our contemporary rightly adds, it might with just as much reason be alleged against hanging that it produces disfigurement of the neck. We have so frequently alluded to what may be termed "newspaper science," and so much of the horrible has been brought into this matter by interested persons on the New York press, that it is quite refreshing to find the *Referee* giving vent to expressions like the following:—"Probably there is no human being more ignorant of the commonest fact of scientific experience than your hack newspaper writer."

The Electrical Transmission of Power in France.

THE utilisation of the motive forces represented by the great falls in France, which, until lately, have not been turned to account, is now being extensively developed. The installation of Revel-Domène (Isère), which we have already described and which now furnishes a motive force of 300 horse-power, is about to be extended so as to furnish 2,000 horse-power, with a view to the distribution of this power amongst the different industries of the town of Grenoble situated at 14 kilometres from the fall utilised. M. Hillairet, whose reputation has been made by his connection with these enterprises, is to construct the machines which will be used. M. Hillairet also constructs for the firm of Chevraut and Bernard Bros., with the collaboration of Messrs. Perrin and Gros, contractors of St. Michel (Savoy), the machines necessary for the transport of 6,000 hydraulic horse power, represented by a fall of 134 metres, giving out at least 3,500 litres per second. This installation, which is now in course of construction, is the forerunner of another of much greater importance which will utilise a fall of 600 metres giving out also 3,500 litres per second at least, and representing a power amounting to 28,000 horse-power in round numbers. We may see, by these instances, that if France has been somewhat slow to enter into the movement of the utilisation of natural motive forces by electricity, she is at least in a fair way to make up for lost time.

The London Conuty Council.

WE are pleased to see that the case of the City and South London Railway Company *v.* the London County Council, has been decided on a second appeal in favour of the former. With all the bribery and corruption which, as was ultimately discovered, characterised the proceedings of the now defunct Board of Works, we believe that seventy-five people out of one hundred would rather see the municipal business and works carried on under the old *régime*. In a multitude of ways the London County Council has made itself obnoxious and perfectly ridiculous, and we congratulate the Company on having shown this to be the case in one phase of the cycle of operations over which the Council holds sway.

Note on the "Vector Potential."

THE use of the "Vector Potential" by electricians has, up to the present, been greatly restricted on account of the many difficulties which surround it, difficulties chiefly of a mathematical nature, and there is a general tendency amongst those who are not well versed in the higher branches of mathematics to dispense as much as possible with this so-called "Vector Potential." The July number of the *Philosophical Magazine* contains an important paper upon this subject by Prof. Arthur Schuster, F.R.S., who renews the discussion of some well-known equations. He was led to make this mathematical investigation through an attempt to find the magnetic effects of currents distributed through space in such a way that the lines of flow should be identical in form with the lines of induction in certain simple magnetic systems. For example, it might be desired to find the components of magnetic force which are produced by currents in an unlimited homogeneous conductor, the electrical potential at every point being the same as the magnetic potential due to a simple magnetic shell. The case could be realised by a conductor in which a constant electromotive force is distributed over a finite surface. Anyone attempting the solution of such a problem would probably be led into considerable difficulties, and Prof. Schuster devotes his paper to the consideration and discussion of this problem. The paper extends over some eleven pages, which are full of closely reasoned mathematics and we should recommend its perusal to any of our readers who are interested in the use of the "Vector Potential," for it may save them some trouble in their own work. One good result of this mathematical investigation is that it has demonstrated that we may always express the magnetic forces due to *steady* currents in a conductor in terms of the values of the currents at the surface of the conductor; the components of the currents inside may be unknown, though, of course, they are determined by the surface values.

ELECTRICAL TRANSMISSION OF POWER.

A SCHEME is proposed by Herr Zipernowsky to be utilised in connection with an electric tramway in Vienna, where it is intended to adopt a car speed of about 25 miles an hour. The scheme refers to a combined system of alternating and continuous currents, the employment of which would permit of the use of water-power situated too far from the working centre to allow of a continuous current method being exclusively adopted. The outline of the system proposed is the arrangement in a distant place of alternating current dynamos producing electrical energy at 10,000 volts. From this generating station the current would be transmitted—doubtless by means of overhead conductors—to a subsidiary station, where it would operate alternating current motors. These would be set in motion by separate machines, and would be maintained in movement until they were in synchronism or in step with the generating alternators. Then the "starters" would be disconnected and the motors run in accord with the primary machines, when the motors would be caused to actuate continuous current dynamos which would furnish electrical energy direct to the driving motors on the tramcars.

The originality, if any, of the method proposed appears to lie in the facts that the alternators are suggested to be used as the primary means of obtaining a cheap supply of power for traction purposes, and in the combination of the two systems for that purpose. As far as the high tension system for long distance transmission is concerned, we believe that there are several examples in Europe where that method is employed in conjunction with continuous current machines for the operation of machinery, but not for the purposes of locomotion and lighting, and certainly not with a potential of 10,000 volts. If we remember rightly, there are several similar and recent instances in the mountainous districts of the United States, where fuel is expensive. In these cases, also, the driving of machinery, and the production of light, are the only uses made of the combined systems, and the alternating current motors are said to keep well in step with the generating machines.

Up to the present experiments have not shown what may be the prospective results of very high tension currents. The Lauffen-Frankfort scheme, with its 20,000 volt pressure, will no doubt help to enlighten many on this important point, and will probably tend to assist in the carrying out of Herr Zipernowsky's project. With the latter the chief difficulties appear to be the efficient insulation of the conductors, and the synchronising of the motors, with the generators at 10,000 volts. What is really required is some practical information on the performances of alternating current motors, about which the Frankfort Technical Commission reported slightly some time ago.

THE CONSTRUCTION AND PROPERTIES OF INDUSTRIAL CONDENSERS.

UNTIL the last few years, the employment of condensers in electrical industry was limited to the construction of standards for measuring the capacities of submarine cables, and to the establishment of capacities used in telegraphy for compensating the capacities of telegraph lines, or for hastening the variable period of the establishment of the current in automatic transmissions. In none of these applications has the condenser been subjected to a tension exceeding some hundred volts. The development of applications of alternating currents, a development which, seven or eight years ago, was scarcely anticipated, has directed our attention to the important question which forms the subject of this article, and relates to the practical construction of industrial condensers of great capacity, capable of resisting alternating currents of high potential and great frequency. The working of certain systems of distribution of electrical energy, and certain applications of alternating currents, such as that of Maurice Leblanc, which we shall describe later, are closely connected with the construction of reliable and cheap condensers. We think, therefore, that it will be of interest to describe briefly the researches made by M. Maurice Leblanc with the object of solving this problem, which directly affects the development of applications of electricity.

The first condensers used by M. Maurice Leblanc were made of paper of very indifferent quality, impregnated with ordinary paraffin, heated to 70° Centigrade. These condensers, which were made by M. Labour, engineer to the Paris Electric Lighting Company, had a capacity corresponding to a specific inductive power equal to eight, but the residual charge amounted to nearly a quarter of the first discharge.

The capacity of the same condensers, when measured by the alternating current method, with a frequency of 75 periods per second, indicated a specific inductive power equal to one-third only of the above. On subjecting these condensers to a difference of potential alternating from 1,500 to 2,000 volts, with the same frequency, the heating produced was sufficient to melt the paraffin, to make the condenser hum, and to destroy it if the current were not quickly interrupted. With paper and paraffin specially selected for the purpose, these results were not improved. By assimilating the paraffin with Poisson's dielectric, *i.e.*, a dielectric covered with conducting spheres, M. Maurice Leblanc found out the causes of the heating of the condenser and of its great increase of specific inductive power, and at last he also found out the way to overcome this great inconvenience. By previously heating the paper in the paraffin to the temperature of dissociation of this latter substance, the organic constitution of the paper is destroyed; the paraffin eliminates any traces of acid it might contain arising from its purification. The paper, on being treated in this way, increases in thickness, and completely changes its appearance, its fibrous texture entirely disappearing, the residual charge becomes insignificant, the condensers manufactured in this way do not become heated any more, and the specific inductive power thus obtained falls to 2·56.

But this mode of preparing the paper involves great expense on account of the quantity of paraffin decomposed. Moreover, as the leaves stick together one after the other, they have to be kept hot so as to be separated one after the other, which constitutes a difficult and delicate operation. This involves a great increase in the price of the labour employed.

While these condensers were being made M. Leblanc made several experiments with the first ones, which, as he considered them defective, he used unsparingly, often subjecting them to differences of potential of 4,000 volts.

Having occasion later on to measure the capacity of some of them, he was surprised to find it much less than had been anticipated. The specific inductive power of the dielectric had become equal to 2·56. He examined them then to see whether the heating had not also decreased, and found that this was the case, as he had expected. These condensers, so faulty at first, no longer became heated, and had turned out excellent.

To remove all doubts on the subject another similar series of condensers was made and they were used for several days, their increase of temperature being carefully noted. All turned out as was expected, the condensers heated less and less, and after ten days of almost continuous experiments under a tension of 1,500 volts, they became equal to the first.

From the above it follows that excellent results may be obtained from paraffined paper, that we need not trouble about the quality of the material if we subject the condensers to a period of probation under the conditions indicated. They must be watched attentively while being used, and allowed to rest when they become heated to any extent.

This is a practical rule which is very easy to follow, a condenser runs no risk as long as it works noiselessly; when it begins to hum it is in danger.

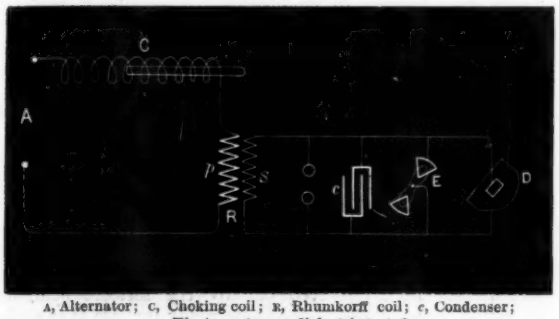
It can easily be understood that what the action of heat had effected in a few hours (three on an average) would be brought about eventually by the electrical displacement produced in the centre of all the conducting particles contained in the mass. This is a fresh proof of that property of alternating currents which is now generally admitted, viz., that their action on dielectrics is beneficial rather than otherwise.

The ebonite condensers gave complete satisfaction. Their capacities, whether measured by the ordinary method or by the employment of alternating currents, were the same; the residual discharge was insignificant. Moreover, they do not

become heated. The sheets of tin were gummed to the plates of ebonite with Chatterton's compound. The sheets of ebonite were kept on a hot plate; they became soft and very supple. The sheets of tin were applied to them by means of an ordinary iron heated. Chatterton's compound seems to answer the purpose best as a mastic. Condensers made in this way form real plates of great solidity.

The thinnest ebonite that could be procured was $\frac{2}{10}$ths of a millimetre in thickness; this was not split under the tension of 11,000 volts, the highest reached. Celluloid also gave good results as a dielectric, but M. Leblanc rejected this material on account of its great inflammability; a spark was sufficient to set fire to it. This objection does not apply in the same degree to the kind known as *American linen*, but Messrs. Hutin and Leblanc did not continue their experiments on this material, as they found they could obtain ebonite at a comparatively low price; 6·25 francs per kilogramme for thicknesses of less than half a millimetre, and 12 francs per kilogramme for thicknesses of less than $\frac{2}{10}$ths of a millimetre. It will even be possible to manufacture this ebonite of a thickness of $\frac{1}{10}$th of a millimetre only.

The accompanying diagram shows the experimental method used by Messrs. Labour, Hutin and Leblanc for studying the



A, Alternator; C, Choking coil; R, Rhumkorff coil; c, Condenser; E, Electrometer; D, dielectric tested.

qualities of different specimens of ebonite from the point of view of their mechanical resistance to high potentials. An alternator, giving about 75 periods per second, is connected with the primary circuit of an ordinary induction coil, the trembler of which is suppressed. Into this primary circuit is introduced a self-induction coil, the inductance of which may be varied by introducing into it a bar of laminated soft iron, so as to vary the intensity of the primary current, and consequently the electromotive force induced in the secondary circuit. This induced electromotive force is, moreover, increased by connecting in derivation on this secondary circuit an ebonite condenser, capable of resisting the highest tensions produced in this secondary circuit, and measured by means of Sir William Thomson's electrostatic voltmeter. In derivation on this condenser were also established two balls mounted on a frame with a micrometric screw, enabling the explosive distances corresponding to each potential to be measured. The dielectric to be tested is placed between the two secondary wires of the induction coil, and forms a sort of condenser with the addition of two little pieces of tinfoil applied to its surface. It is thus easy to determine for each specimen at what potentials the successive signs of deterioration show themselves, viz., splitting, luminous glow, and the appearance of holes, with very bright and powerful sparks, which will set fire to the dielectric if it is inflammable.

THE PLATINUM THERMOMETER.

THE great superiority of the platinum-resistance thermometer over other instruments for measuring temperature lies in its comparative freedom from change of zero. Provided that the wire is pure to start with, and that it is protected from strain and from contamination, its resistance, when once annealed, is always very nearly the same at the same temperature.

This statement was made a few years ago by Mr. H. L. Callender, and was received in some quarters with incredulity and surprise. It was remembered, perhaps, that the Siemens electrical pyrometers have always shown large and continuous changes of zero (*vide* British Association Report, 1874), and that platinum wires when used as filaments for incandescent lamps, undergo more or less rapid deterioration.

The Siemens pyrometer is a commercial and not a scientific instrument, and might be expected to show changes of zero when used at high temperatures; the wire is wound on common clay, which is apt to attack it, and it is enclosed in an iron tube without sufficient protection from the metallic and other vapours which are seen to be present.

In the case of lamp filaments which are heated by a current *in vacuo*, it might appear at first sight as though the wire were imperfectly protected from strain or contamination; but this is far from being the case. The sudden heating or cooling of the wire when the current is turned on or off, and the intense radiation which keeps the surface at a lower temperature than the central portions, must be a severe strain upon the wire. It is also evident that any crack or flaw in the surface will tend to be intensified by the local development of greater heat; and if the wire is heated to a temperature near its melting point when it begins to be appreciably volatile, this action must inevitably produce serious results. If a wire which has been thus treated be examined under the microscope, its surface will generally be found to be cracked and scored in a manner which is of itself amply sufficient to account for the increased resistance and brittleness.

The wire of a platinum thermometer which is properly protected does not undergo any alterations of this kind if treated with reasonable care.

These observations are due to Mr. Callender, who contributes a paper on the construction of platinum thermometers to the current issue of the *Philosophical Magazine*, from which we make the following abstract, leaving our readers to consult the original paper, which is some nine pages in length, for details of its use.

The simplest form of platinum thermometer is made by fusing or welding a coil of fine wire to leads of relatively low resistance. The coil and leads must be suitably insulated and supported; for most purposes it is convenient to enclose the instrument in a tube of similar dimensions to an ordinary thermometer. For use at temperatures below 700° C., the leads may be of copper or silver and the tube of hard glass.

For rough work at temperatures below 1,000° C. very fair results may be obtained by the use of a wrought iron tube. The leads should also be made of iron. Copper and silver are too volatile. Their vapours will attack the platinum and very small traces of either are sufficient to ruin the wires for thermometric purposes.

For accurate work at high temperatures it is necessary to use platinum leads and to enclose the coil in a tube of glazed porcelain or silica.

For insulating the coil and leads Mr. Callender has found nothing that answers so well as mica. Biscuit porcelain is fairly good, but most varieties of clay are apt to attack the wire at high temperatures. If the wire is wound on a clay cylinder, the relatively large mass of the clay has also the effect of materially reducing the sensitiveness.

The wire is preferably doubled on itself like an ordinary resistance coil and wound on a thin plate of mica. The leads are insulated by being made to pass through a series of mica wads cut to fit the tube containing the instrument. This method has the advantage of giving very perfect insulation, and of preventing convection, and currents of air up and down the tube.

The resistance of such an instrument may conveniently be measured by means of an ordinary post office box. If the resistance coils are of German silver wire the temperature of the box must be taken at each observation and a correction applied. It is better therefore to use a box with coils of copper, nickel, manganese, or one of the many other alloys that do not change appreciably in resistance at ordinary temperatures.

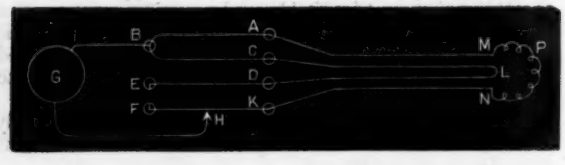
With the above simple arrangement it is not difficult to obtain results consistent to a four hundredth of a degree at 500° C., provided that the resistance of the leads is relatively very small and fairly constant and that the stem of the thermometer is always immersed to nearly the same extent. There are some objections, however, to the use of thick leads. They are necessarily wanting in lightness and flexibility, and they tend to cool the bulb of the thermometer by conduction along the stem.

For most purposes it is better to insert in the stem of the thermometer a second pair of leads similar to those of the coil itself so that the resistance can be measured separately.

It is then possible to use leads of any convenient length and flexibility, and to make the observations of temperature independent of the length of stem immersed.

In the ordinary method of measuring resistance with a post office box, it is necessary to observe galvanometer throws in order to find the last two figures of the value of the resistance. If, however, a divided bridge wire be used in conjunction with the resistance box for determining the fractions of an ohm in the manner described below, the apparatus can at the same time be arranged so that the variable resistance of the leads is eliminated. The reading of the bridge wire scale when the balance is found is then independent of the length of the stem immersed, and gives the temperature of the thermometer coil without the necessity of observing galvanometer throws, or of measuring the resistance of the leads.

The annexed diagram represents the arrangement of the apparatus :—



A B, B C, equal resistances forming the arms of the balance.
A and C, connections for battery.
G, galvanometer.
B, one terminal of galvanometer.
D E, is a set of resistance coils which, together with A B and B C may be supplied by an ordinary post office box.
F K, is a straight bridge wire with divided scale.
H, a contact piece which slides along this wire and to which the other terminal of the galvanometer is attached.
P, the pyrometer coil.
A M, K N, leads from the pyrometer coil.
A K, attachments of these leads.
C L, L D, compensating leads.
C D, attachment of these leads.

These four leads may be of any convenient length ; they are symmetrically arranged so that corresponding parts are always at the same temperature.

When the balance is found by unplugging suitable resistances in the arm, D E, and sliding the contact piece, H, it is plain that since the resistances, A B, B C, are equal, the resistance of the pyrometer and its leads, plus that of the length, H K, of the bridge wire, will be equal to the resistance of the remaining portion, F K, of the bridge wire, together with that of the coils, D E, and the compensater. Thus the changes of resistance of the pyrometer leads, A M, K N, are compensated by equal changes in the leads, C L, L D, and the resistance of the pyrometer coil itself is directly given by the sum of the coils, D E, and the reading of the bridge wire.

It is convenient to graduate the bridge wire scale so that 100 or 200 divisions are equivalent to the unit coil in the arm, D E. It is also convenient to adjust the resistance of the pyrometer coil, so that the change of its resistance between 0° and 100° C. may be equal to 1, 10, or 100 units. The divisions of the bridge wire will then represent degrees of temperature on the platinum scale, and the temperature can be deduced from the observed resistance by simply subtracting its zero value. Thus an observation of temperature is reduced to a single scale reading. By suitable arrangements a platinum thermometer can be made to do the work of a whole series of mercury thermometers. We have given our readers the chief features of the construction of these thermometers ; for further details as to use as well as for the theoretical considerations, we refer them to the original paper.

Lighting in Italy.—The town of Orbeullo is now publicly lighted by electricity, and private illumination is also effected by the same agency.

AN APPLICATION OF ORGANIC ACIDS AND ELECTROLYSIS TO THE MANUFACTURE OF COPPER.

IN this improved process of manufacturing copper, which is due to the ingenuity of H. H. Vivian, the impurities are dissolved out of the finely divided and previously oxidised raw material by means of some organic acid.

Let us suppose that the raw material is impure metallic copper. In order to obtain pure copper from it, it is first melted, then granulated, then roasted, by which latter process it is oxidised ; the oxide is then finely ground and submitted to extraction with the organic acid.

If the raw material is a "matte" this is first ground and then roasted.

Towards the end of the roasting operation, it hastens matters if a little common salt is added, and well mixed in with the charge. This addition appears to facilitate the subsequent extraction.

Having brought the raw material to the condition of oxide the next step is to lixiviate it with a solution of tartaric acid in water. The effect of this is to dissolve out any antimony, arsenic, gold, silver, or other foreign substances which may happen to be present. A residue is now left which has to be reduced to the metallic state. The reduction is performed in a reverberatory furnace, the residue being well mixed with broken carbon, which of course combines with the oxygen of the oxides and so passes away. The copper obtained by this process is stated to be of a very high quality.

We now come to the electrolytic features of this process. The tartaric acid solution, containing the arsenic, antimony, silver, &c., is saved after the lixiviation, and is then submitted to the decomposing action of an electric current, insoluble anodes being employed. By this treatment any metals occurring in the original copper as impurities, and which have been dissolved out by the tartaric acid, are deposited, leaving the acid liquor ready for use over again. It thus appears that this process is a highly economical one.

Other acids besides tartaric may be employed, for instance, oxalic, citric, and acetic ; and similar good results are stated to be obtainable.

The quantity of tartaric acid used for every ton of oxide is about two pounds dissolved in one hundred pounds of water.

It is not absolutely essential that the matte (if that be the raw material used) should be roasted, for it is said to be much improved if it is finely powdered and treated directly with the acid liquor.

ELECTRICAL PHENOMENA DEVELOPED IN THE FORMATION OF SOLID CARBONIC OXIDE.

CARBONIC oxide, which under normal conditions of temperature and pressure, is a gas that may easily be obtained in the solid condition by first compressing it in iron cylinders till it becomes liquid, and then allowing the liquid compound to evaporate rapidly into a bag made of sail-cloth.

If this experiment be performed in the dark, it has recently been observed by G. Haussknecht that the evaporation and consequent formation of the solid substance is accompanied by brilliant electrical phenomena. A bag of capacity, about one or two litres, was employed, and when the liquid was allowed to evaporate rapidly into the bag, it was seen to be surrounded and permeated with a pale, greenish-violet light and electric sparks, varying in length from ten to twenty centimetres, shot out through the interstices of the bag.

When the hand was brought in contact with the bag or with the sparks that flew out from it, the same curious sensation was observed as is experienced with a "frictional" or "influence" electric machine.

The cause of these electrical phenomena seems to be probably the same as in Armstrong's gas electric machine. As the liquid carbonic oxide rapidly evaporates the gas rushes out from the orifice of the cylinder, and impinging upon the bag is pressed through the fine openings in the sail-cloth, and thus there is strong friction. The action also sets up fric-

tion between the solid and liquid particles of the carbonic oxide.

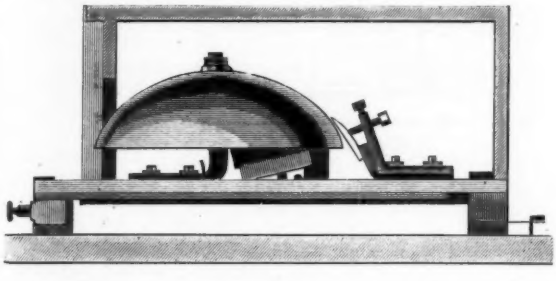
An essential condition of success in producing this phenomena is that the carbonic oxide should be pure or at least unmixed with atmospheric air.

The pale-greenish-violet light is first developed when a crust of solid carbonic oxide of about 0·5 to 1·0 cm. in thickness has formed in the bag.

It very often happens that such phenomena as these pass without being investigated, but in this case it is satisfactory to learn that Haussknecht not only records his observations, but announces his intention of examining into the nature of the phenomena and determining quantitatively the electricity generated. These researches are recorded in full in the *Berichte der deutschen chemischen gesellschaft* xxiv., p. 1,031.

AN ELECTRO-MAGNETIC BELL.

A PLEASING novelty has recently been invented by MM. Guerre and Martin in the form of an electro-magnetic bell, which, instead of giving out the shrill unmusical note which is usually characteristic of electric bells, gives a clear ringing musical sound which is equally remarkable for its purity of tone as well as for its intensity. They call the sound a "bourdon," and it compares very favourably with that of a diapason of the same period.



The vibratory movement of the gong, which is made of steel, is so regular that it gives the impression of a single note instead of a succession of clanging noises.

At a recent meeting of the Academy of Science at Paris, MM. Guerre and Martin exhibited their new bell and explained the scientific principles upon which it is based. We hear that this invention has been applied in the construction of a musical instrument which is called the *palsiphone*.

The simplest form is shown in the accompanying figure.

TESLA'S SYSTEM OF ELECTRIC LIGHTING WITH CURRENTS OF HIGH FREQUENCY.

IN his lecture delivered before the American Institute of Electrical Engineers,* Mr. Nikola Tesla dwelt at length upon the fact that the direct application of electro-magnetic waves to the production of luminous effects was impracticable and that for this purpose electro-static waves or thrusts must be employed. To make these effects available in practice, however, it is necessary to employ currents of very high frequency and of very high potential.

In a patent just issued to Mr. Tesla on this method of electric illumination, he draws attention to the mechanical difficulty of obtaining the necessary high frequency of alternations, and hence he avails himself of the principle of the disruptive discharge. The current of high frequency is produced by the disruptive discharge of the accumulated energy of a condenser maintained by continuously charging the condenser and discharging it disruptively, in connection with an induction coil which generates the high potentials required.

The accompanying diagram, fig 1, illustrates the method employed by Mr. Tesla, the generator in this case being one delivering alternate currents of comparatively low potential. The potential of the current is raised by means of an induction-coil having a primary, P, and a secondary, S. Then by the current developed in this secondary a condenser, C, is charged, and this condenser discharged into a circuit, A, having an air-gap, *a*. By the means above described, a current of enormous frequency is produced. It is next necessary to convert this into a working circuit of very high potential, for which purpose there is connected up in the circuit, A, the primary, P', of

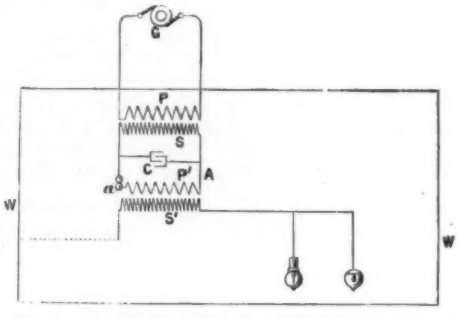


FIG. 1.—TESLA'S NEW SYSTEM OF ELECTRIC LIGHTING.

an induction-coil having a long fine wire secondary, S'. The current in the primary, P', develops in the secondary, S', a current or electrical effect of corresponding frequency, but of enormous difference of potential, and the secondary, S', thus becomes the source of the energy to be applied to the purpose of producing light.

The light-giving devices may be connected to either terminal of the secondary, S'. If desired one terminal may be connected to a conducting-wall, W, of the room to be lighted and the other arranged for connection of the lamps therewith. In such case the walls should be coated with some metallic or conducting substance in order that they may have sufficient conductivity.

Mr. Tesla has devised several forms of lamps to be used in

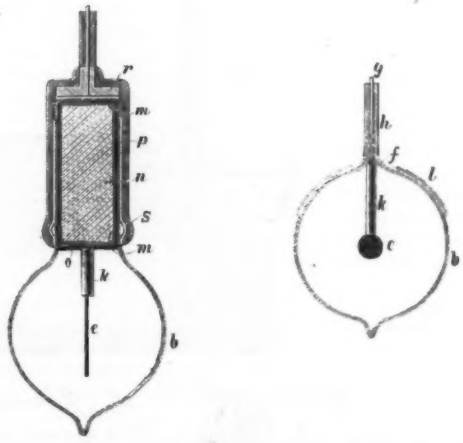


FIG. 2.—TESLA'S LAMP WITH STRAIGHT FILAMENT, ONE INSIDE AND ONE OUTSIDE CONDENSER COATING, AND ONE CONDUCTOR.

FIG. 3.—TESLA'S LAMP WITH INCANDESCENT BALL AND ONE CONDUCTOR.

connection with his system, two forms of which are shown in the engravings figs. 2 and 3. In the former the globe, *b*, is formed with a cylindrical neck, within which is a tube or sheet, *m*, of conducting material on the side and over the end of a cylinder or plug, *n*, of insulating material. The lower edges of this tube are in electrical contact with a metallic plate, *o*,

* *The Electrical Engineer*, May 27th, 1891.

secured to the cylinder, *n*, all the exposed surfaces of the plate and of the other conductors being carefully coated and protected by insulation. The light-giving body, *e*, a straight stem of carbon, is electrically connected with the plate by a conductor, *f*, which is coated with a refractory insulating material, *k*. The neck of the globe fits into a socket composed of an insulating tube or cylinder, *p*, with a more or less complete metallic lining, *s*, electrically connected by a metallic plate, *r*, with a conductor, *g*, that is attached to one pole of the source of current. The metallic lining, *s*, and the sheet, *m*, thus compose the plates of a condenser.

Fig. 3 shows a lamp containing an incandescent body, *e*, which is connected to one pole of the source of current. Outside of the globe the conducting-wires are protected by a coating of insulation, *h*, and inside the globe the supporting-wire is inclosed in and insulated by a coating, *k*, of a refractory insulating substance, such as pipe-clay. A reflecting-plate, *l*, is shown applied to the outside of the globe, *b*. This form of lamp is a type of those designed for direct electrical connection with one terminal of the source of current; but, as in the case of the lamp, fig. 2, there need not be a direct connection, for the carbon or other illuminating body may be rendered luminous by inductive action of the current thereon.

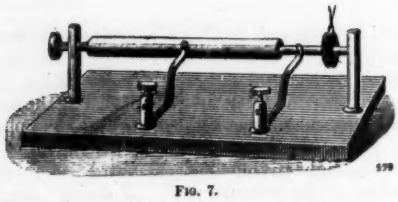


FIG. 7.

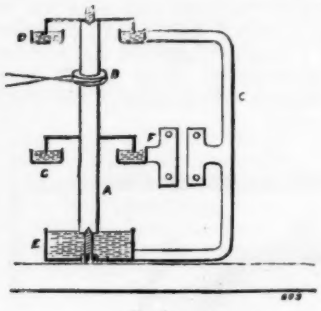
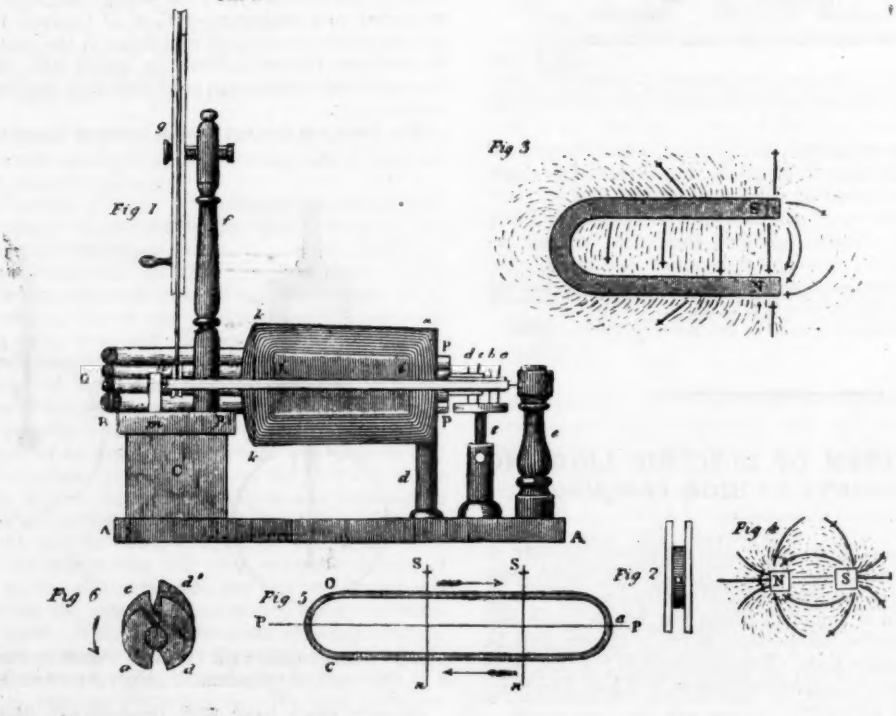


FIG. 8



AN EARLY DYNAMO MACHINE.*

AN interesting chapter in the history of the development of the modern dynamo-electric machine is to be found in William Sturgeon's "Scientific Researches," a folio containing 563 pages and 19 copper-plate engravings, printed in 1850 by Thomas Crompton, of Bury, and published by subscription. This interesting work contains a list of 251 subscribers, mostly Lancashire folk. Among the names of subscribers are to be noticed those of Michael Faraday and James Prescott Joule; and it may facilitate access to this exceptionally interesting work if we mention such libraries as appear in the subscription list: Chetham's Library, Manchester; University Library, Edinburgh; Library of the Royal College of Physicians, Edinburgh; Library of the Non-Commissioned Officers, Royal Artillery, Woolwich; Worsley Library. In spite of the fact that the work contains a vast amount of electrical research and speculation, Sturgeon evidently looks upon his spindle armature magneto machine with commutator for setting the currents in one direction (unio-directive discharger), as one of his most important inventions, and in the preface he thus refers to it (page vi.).

"The magneto-electrical machine represented by figs. 1 and 7,* plate XII., has some years since found its way into the specification of a patent by Mr. Woolrich, of Birmingham, for the purpose of electro-gilding and silvering, notwithstanding my having published the same plan a long time previously, and pointed out its superiority over that in which voltaic batteries are used. The first announcement of my apparatus was in a paper read before the Royal Society, June 16th, 1836, in which it was stated that I had coated metals from metallic solutions by means of the magnetic electrical apparatus; and in a small work on 'Electro-Gilding and Silvering,' published March 1st, 1842, I particularly stated the application of the same machine in the process of gilding and silvering in the following words:

* *Engineering.*

* Fig. 1 has a spindle armature and fig. 7 has a horseshoe armature; each having the one-direction commutator.

'It is now more than seven years since I contrived a magnetic electric machine that produced continuous electric currents, by means of which I coated metals with tin, copper, &c., and I have employed the same machine to great advantage in silvering, gilding, and platinising various kinds of metal of inferior value, and I have no doubt that in this capacity the magnetic electrical machine will becóme generally useful.'"

The paper read before the Royal Society (June 16th, 1836), is reprinted on page 251, *et seq.*, of the work now under notice, and commences by pointing out the general advantages of magnetic machines over batteries. Next comes a description of the spindle armature machine, in which a longitudinal coil revolves between the arms of the magnet. Sturgeon also realised what is generally looked upon as a quite modern discovery, that in this type of armature an iron core may be dispensed with.

Fig. 1 shows the machine with the near limb of the compound horseshoe magnets removed and the armature in section. The following is from Sturgeon's description: "The spindle, *i*, *i*, passes through the pillar, *f* (which supports the wheel, *g*), and also through the axis of the reel, *k*, *k*, *k*, *k*, to which it is fixed. On the reel is coiled 200 feet of copper wire, about $\frac{1}{20}$th inch in diameter, and covered with stout white sewing silk, to prevent metallic contact in the coil. The reel which holds the wire is made of two thin pieces of deal, of the shape, *k*, *k*, *k*, *k*, which form the cheeks, and are kept at about 1¼-inch apart and parallel to each other by the pieces which cross them for the reception of the wire. The extremities of the wire terminate in a discharging arrangement to be described in the sequel." The magnet used was a four-bar horseshoe magnet weighing 23 lbs., the limbs being 5 inches apart at the poles, and about 6 inches apart near the bend; hence will be seen the reason for the two long sides of the coil not being quite parallel. Fig. 2 represents the core of the armature in end view and shows the hole for the axis. Sturgeon continues: "When the magnet is placed on the stage, its plane is parallel to the plane of the base board. The spindle, *i*, *i*, which is also parallel to the axis of the base board, is situated in the axis of the magnet. By this arrangement the coil is made to revolve between the branches of the magnet, and electric currents are excited whilst the coil travels through the magnetic lines." Sturgeon now refers to fig. 5 as representing the wire circuit, and fig. 3 as representing the magnetic field, and at some length traces out the phases of current production, much in the same words as may be met with in a text-book of the present day. He then describes a number of experiments with the machine, and afterwards he alludes to a machine with a horseshoe armature, and also the one-direction commutator. The structure of the one-direction commutator will be sufficiently obvious from the sketches, small hollows containing mercury fulfilling the functions of the ordinary brushes, and as these obviously have to be horizontal, the commutator must be made double, as shown by fig. 6, segments *c* and *d* being connected with one end of the wire, while segments *a* and *d*¹ are connected with the other end. Sturgeon, however, evidently did not confine himself to the commutator with mercurial brushes, as in an appendix (p. 275) to the memoir, he refers very emphatically to the inconvenience of using mercury, and advocates the use of "discharging pieces or springs, lubricated by sweet oil whilst pressing upon the metallic arcs attached to the revolving spindle," and he says this contrivance was first described by him in the *London and Edinburgh Philosophical Magazine* for September, 1835. In another appendix (p. 274) he says, "Mr. Christie, one of the council of the Royal Society, saw some of these experiments with the spring discharger attached to the machine, at my house, within a week after my paper was read. At that time the machine would liberate one cubic inch of gas from acidulated water in eight minutes, showing an increase of power equal to one-third of that which it exerted with the mercurial polar cells."

Sturgeon's collected account of his researches presents many other points of interest, especially in relation to numerous rotation experiments, both with thermo-currents and battery currents, several of these touching on matters which have scarcely found place in modern text-books; and some of the most interesting relate to the rotation of a magnet about its axis when the magnet itself carries the actuating current, an arrangement which gives us the simplest electric motor or dynamo known; armature and field being one. Such an arrangement is referred to (as generator) in Mrs. Mary Somerville's "Connection of the Physical Sciences," second edition, London, 1835, page 361, who says: "When a magnet revolves uniformly about its own axis, electricity of the same kind is collected at its poles, and the opposite electricity at its equator." The experimental proof of this is quite easy, if a round bar of magnetised steel is carefully centred on a quick-running lathe and light tinfoil brushes are used. It is worth mentioning that one modern book at least deals with this simple form of dynamo, as in Prof. Oliver Lodge's "Modern Views of Electricity," Macmillan, 1889, page 146, we have a drawing of the dynamo in question, see fig. 7.

In reference to the dynamo represented above, Professor Lodge says: "Spinning the magnet mechanically gives a current between two springs, one touching it near or beyond either end, the other touching it near the middle."

Such a dynamo as that mentioned by Mrs. Mary Somerville and by Dr. Lodge gives, as might be expected, a low potential, but an apparatus of very small size will give sufficient tension for the deposition of copper, and it would not surprise us if a slight modification of this form should prove specially suitable for such purposes as welding, where a large current of low tension is needed. In such a case the resistance at the brushes would probably have to be reduced by such a device as setting the magnet vertically and making the circuit through mercury cups; the top or middle cup being, of course, annular, and having the bottom end of a vertical conducting cylinder dipping in it.

The sketch (fig. 8) on the preceding page will serve to indicate a possible arrangement.

It is sufficiently obvious that electro-magnets can be used instead of permanent magnets in such a case as this, and that the self-exciting principle is applicable.

THE WILLSON ELECTRIC ALUMINIUM PROCESS.*

IN the production of aluminium and its alloys, or other metals of equally refractory character, by means of the electric current, the ore is fused and decomposed, and the oxygen thus liberated attacks the containing crucible and the electrodes, which are usually made of carbon, by means of which the current is introduced and rapidly wastes them away. The material of the electrodes and crucible is thus made to act as a reducing agent, and the process of electric smelting is rendered expensive.

In order to avoid this loss, Mr. Thomas L. Willson, of Brooklyn, the electrical engineer of the Willson Aluminium Company of this city, has devised a method of introducing a de-oxidising agent in the form of a hydrocarbon gas, so that it shall be interposed between the liberated oxygen, and the surfaces of crucible and electrodes.

The hearth is of brickwork having an opening within which the crucible is set resting upon a carbon plate built into the hearth, and forming the bottom of the opening. The positive and negative terminals of the dynamo are connected respectively with the carbon plate and a carbon pencil. The connection with the carbon plate is made through the medium of a metal bar.

The carbon electrode is made tubular, the duct through it constituting a gas passage. The upper end of the carbon-rod has united to it an iron pipe, which extends upward in line with the carbon rod, and is connected to the supply of gas. A gas holder is provided to equalise the pressure of the gas.

The operation will now be readily understood. In the bottom of the crucible is placed a quantity of broken copper, and, on top of this a layer of alumina in the form of a nearly pure corundum.

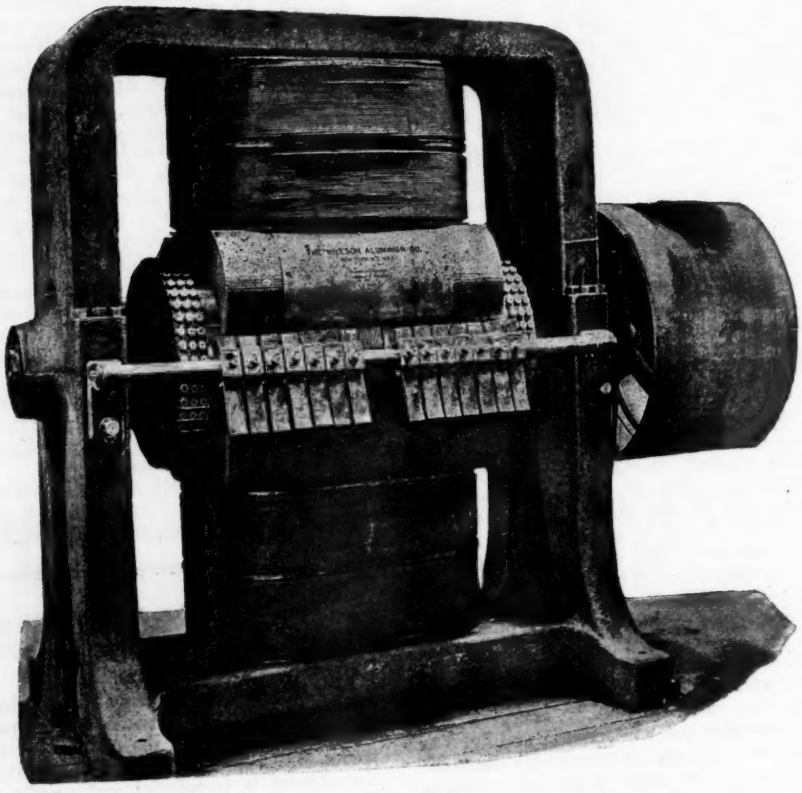
The cover is then placed over the crucible and luted down, and the carbon pencil thrust through it and pressed down through the layer of corundum until its tip touches the copper. After the current has been started by bringing the carbon pencil in contact with the copper, the carbon pencil is lifted slightly to strike the arc, and as the copper fuses it is lifted still higher until the maximum arc is formed. This arc is then maintained stationary. At the same time the

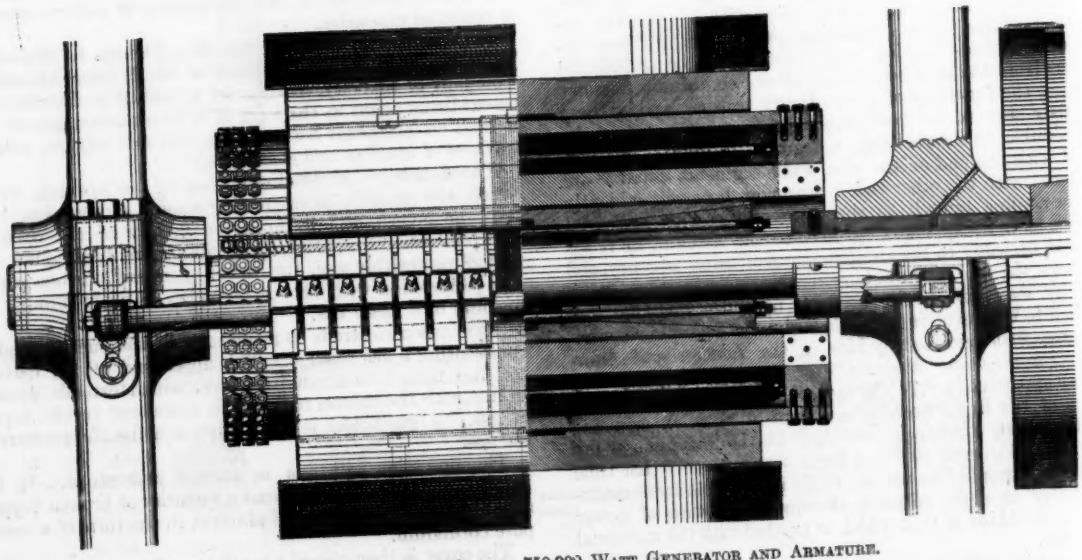
* *Electrical Engineer*, of New York.

gas is turned on, and during the operation the pump is kept running at sufficient speed to supply the desired quantity of gas at the proper pressure. This pressure should be sufficient to overcome any pressure existing in the furnace, and to cause a slight blowing out of the gaseous products of combustion through the vent.

The heat of the arc first fuses the copper and sets it into ebullition, partially vaporising it. As the heat becomes more intense the alumina is also fused and is decomposed, its oxygen being set free and immediately combining with the hydrocarbon gas pumped in and forming carbonic acid, carbonic oxide, and steam, which escape through the vent. The aluminium, which is freed from its combination with oxygen, at once combines with the copper, forming an aluminium bronze. Throughout the operation the copper is vaporised by the intense heat, and the copper vapours circulate within the crucible, becoming condensed against the comparatively cool sides and streaming down as liquid copper through the mass of corundum, whereby a circulation is created through the latter, and as rapidly as the corundum is fused and its oxygen driven off, the copper combines with the aluminium. The operation consumes from fifteen minutes to two hours, depending upon the character of the corundum, the proportions of the ingredients, and the strength of the current.

When the corundum has been wholly fused and melted down, and its oxygen eliminated, there remains in the crucible a bath of molten aluminium bronze, which is poured or





FIGS. 1 AND 2.—THE WILLSON 750,000 WATT GENERATOR AND ARMATURE.

tapped out of the crucible. A special type of dynamo to be used in connection with this process has been designed and built by Mr. Willson, and is shown in the engraving, fig. 1. This machine weighs 25,442 lbs. It has a 24-inch Gramme armature, weighing 6,163 lbs., mounted upon a 5-inch hammered steel shaft. The shaft bearings are of composition brass, 15 inches long. There are over 11,000 lbs. of cast iron in the frame of the machine, and 7,000 lbs. of forged iron in the pole pieces, &c.; and altogether it contains 7,456 lbs. of copper in the fields and armature. The capacity of the dynamo is 750,000 watts at 530 revolutions per minute, and it is designed to run at 50 volts.

One of the special features of this machine is the arrangement of the brushes, which, as will be noted, are placed directly against the outer surface of the armature bars; the commutator as such is thus done away with. The armature bars, which are 1½ sq. inch in section, are thoroughly insulated with asbestos and with mica where the brushes bear, and are practically indestructible. One armature of this type, after four years of constant operation, shows not more than $\frac{1}{32}$nd inch reduction of size. As will be seen by reference to fig. 2, no spiders are used, and the shaft is gripped by an expansion hub, the friction being automatically taken up by means of a constant spring pressure. Tests of the machine have shown it to run remarkably cool and to possess a high efficiency.

The machine illustrated has been constructed by Mr. Willson for the Willson Aluminium Company, and will shortly be put in operation at Leaksville, N.C., for the extraction of pure aluminium and its alloys by the Willson process as described above. A large water power is available for driving the dynamo, and it is believed that, with the new process, together with the cheapness of the power, it will be possible to produce aluminium both pure in quality and at a considerably reduced cost.

ELECTRIC DISCHARGE IN VACUUM TUBES.

BY NIKOLA TESLA.

IN the *Electrical Engineer* of June 10th, I have noted the description of some experiments of Prof. J. J. Thomson, on the "Electric Discharge in Vacuum Tubes," and in your issue of June 24th, Prof. Elihu Thomson describes an experiment of the same kind. The fundamental idea in these experiments is to set up an electromotive force in a vacuum tube—preferably devoid of any electrodes—by means of electro-magnetic induction, and to excite the tube in this manner.

As I view the subject, I should think that to any experimenter who has carefully studied the problem confronting us and who has attempted to find a solution of it, this idea must present itself as naturally, as, for instance, the idea of replacing the tinfoil coatings of a Leyden jar by rarefied gas and exciting luminosity in the condenser thus obtained by repeatedly charging and discharging it. The idea being obvious, whatever merit there is in this line of investigation must depend upon the completeness of the study of the subject and the correctness of the observations. The following lines are not penned with any desire on my part to put myself on record as one who has performed similar experiments, but with a desire to assist other experimenters by pointing out certain peculiarities of the phenomena observed, which, to all appearances, have not been noted by Prof. J. J. Thomson, who, however, seems to have gone about systematically in his investigations and who has been the first to make his results known. These peculiarities noted by me would seem to be at variance with the views of Prof. J. J. Thomson, and present the phenomena in a different light.

My investigations in this line occupied me principally during the winter and spring of the past year. During this time many different experiments were performed, and in my exchanges of ideas on this subject with Mr. Alfred S. Brown, of the Western Union Telegraph Company, various different dispositions were suggested which were carried out by me in practice. Fig. 1 may serve as an example of one of the many forms of apparatus used. This consisted of a large glass tube sealed at one end and projecting into an ordinary incandescent lamp bulb. The primary, usually consisting of a few turns of thick, well-insulated copper sheet was inserted within the tube, the

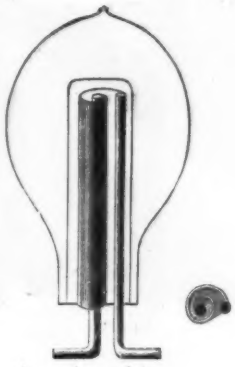
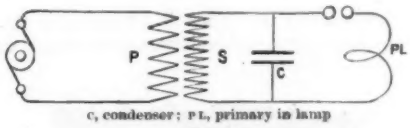


FIG. 1.

inside space of the bulb furnishing the secondary. This form of apparatus was arrived at after some experimenting and was used principally with the view of enabling me to place a polished reflecting surface in the inside of the tube, and for this purpose the last turn of the primary was covered with a thin silver sheet. In all forms of apparatus used there was no special difficulty in exciting a luminous circle or cylinder in proximity to the primary.

As to the number of turns, I cannot quite understand why Prof. J. J. Thomson should think that a few turns were "quite sufficient," but lest I should impute to him an opinion he may not have, I will add that I have gained this impression from the reading of the published abstracts of his lecture. Clearly, the number of turns which gives the best result in any case, is dependent on the dimensions of the apparatus, and, were it not for various considerations, one turn would always give the best result.

I have found that it is preferable to use in these experiments an alternate current machine giving a moderate number of alternations per second to excite the induction coil for charging the Leyden jar which discharges through the primary—shown diagrammatically in fig. 2—as in such case,



C, condenser; PL, primary in lamp

FIG. 2.

before the disruptive discharge takes place the tube or bulb is slightly excited and the formation of the luminous circle is decidedly facilitated. But I have also used a Wimshurst machine is some experiments.

Prof. J. J. Thomson's view of the phenomena under consideration seems to be that they are wholly due to electro-magnetic action. I was, at one time, of the same opinion, but upon carefully investigating the subject I was led to the conviction that they are more of an electrostatic nature. It must be remembered that in these experiments we have to deal with primary currents of an enormous frequency or rate of change and of a high potential, and that the secondary conductor consists of a rarefied gas, and that under such conditions electrostatic effects must play an important part.

In support of my view I will describe a few experiments made by me. To excite luminosity in the tube it is not absolutely necessary that the conductor should be closed. For instance, if an ordinary exhausted tube (preferably of large diameter), be surrounded by a spiral of thick copper wire serving as the primary, a freely luminous spiral may

be induced in the tube, roughly shown in fig. 3. In one of these experiments a curious phenomenon was observed; namely, two intensely luminous circles, each of them close to a turn of the primary spiral, were formed inside of the tube, and I attributed this phenomenon to the existence of nodes on the primary. The circles were connected by a

FIG. 3.

faint luminous spiral parallel to the primary and in close proximity to it. To produce this effect I have found it necessary to strain the jar to the utmost. The turns of the spiral tend to close and form circles, but this, of course, would be expected, and does not necessarily indicate an electro-magnetic effect; whereas the fact that a glow can be produced along the primary in the form of an open spiral argues for an electrostatic effect.

In using Dr. Lodge's recoil circuit, the electrostatic action is likewise apparent. The arrangement is illustrated in fig. 4. In his experiment two hollow exhausted tubes, H H, were

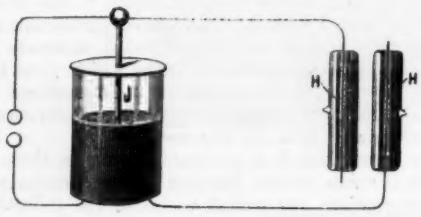


FIG. 4.

slipped over the wires of the recoil circuit and upon discharging the jar in the usual manner, luminosity was excited in the tubes.

Another experiment performed is illustrated in fig. 5. In this case an ordinary lamp bulb was surrounded by one or

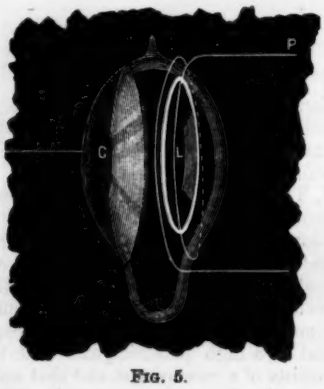


FIG. 5.

two turns of thick copper wire, P, and a luminous circle, L, excited in the bulb by discharging the jar through the primary. The lamp bulb was provided with a tinfoil coating on the side opposite to the primary, and each time the tinfoil coating was connected to the ground or to a large object the luminosity of the circle was considerably increased. This was evidently due to electrostatic action.

In other experiments I have noted that when the primary touches the glass the luminous circle is easier produced and is more sharply defined; but I have not noted that, generally speaking, the circles induced were very sharply defined, as Prof. J. J. Thomson has observed; on the contrary, in my experiments they were broad and often the whole of the bulb or tube was illuminated; and in one case I have observed an intensely purplish glow, to which Prof. J. J. Thomson refers. But the circles were always in close proximity to the primary and were considerably easier produced when the latter was very close to the glass, much more so than would be expected assuming the action to be electromagnetic and considering the distance; and these facts speak for an electrostatic effect.

Furthermore, I have observed that there is a molecular bombardment in the plane of the luminous circle at right angles to the glass—supposing the circle to be in the plane of the primary—this bombardment being evident from the rapid heating of the glass near the primary. Were the bombardment not at right angles to the glass the heating could not be so rapid. If there is a circumferential movement of the molecules constituting the luminous circle, I have thought that it might be rendered manifest by placing within the tube or bulb, radially to the circle, a thin plate of mica coated with some phosphorescent material, and another such plate tangentially to the circle. If the molecules would move circumferentially, the former plate would be rendered more intensely phosphorescent. For want of time I have, however, not been able to perform the experiment.

Another observation made by me was that when the specific inductive capacity of the medium between the primary and secondary is increased, the inductive effect is augmented. This is roughly illustrated in fig. 6. In this case luminosity

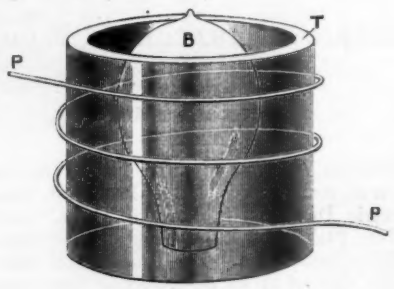


FIG. 6.

was excited in an exhausted tube or bulb, B, and a glass tube, T, slipped between the primary and the bulb, when the effect pointed out was noted. Were the action wholly electromagnetic no change could possibly have been observed.

I have likewise noted that when a bulb is surrounded by a wire closed upon itself and in the plane of the primary, the formation of the luminous circle within the bulb is not prevented. But if instead of the wire a broad strip of tinfoil is glued upon the bulb, the formation of the luminous band was prevented because then the action was distributed over a greater surface. The effect of the closed tinfoil was no doubt of an electrostatic nature, for it presented a much greater resistance than the closed wire and produced therefore a much smaller electro-magnetic effect

Some of the experiments of Prof. J. J. Thomson also would seem to show some electrostatic action. For instance, in the experiment with the bulb enclosed in a bell jar, I should think that when the latter is exhausted so far that the gas enclosed reaches the maximum conductivity, the formation of the circle in the bulb and jar is prevented because of the space surrounding the primary being highly conducting; when the jar is further exhausted the conductivity of the space around the primary diminishes and the circles appear necessarily first in the bell jar, as the rarefied gas is nearer to the primary. But were the inductive effect very powerful they would probably appear in the bulb also. If, however

the bell jar were exhausted to the highest degree they would very likely show themselves in the bulb only, that is, supposing the vacuous space to be non-conducting. On the assumption that in these phenomena electrostatic actions are concerned we find it easily explicable why the introduction of mercury or the heating of the bulb prevents the formation of the luminous band or shortens the after-glow; and also why in some cases a platinum wire may prevent the excitation of the tube. Nevertheless some of the experiments of Prof. J. J. Thomson would seem to indicate an electromagnetic effect. I may add that in one of my experiments in which a vacuum was produced by the Toricellian method, I was unable to produce the luminous band, but this may have been due to the weak exciting current employed.

My principal argument is the following: I have experimentally proved that if the same discharge which is barely sufficient to excite a luminous band in the bulb when passed through the primary circuit be so directed as to exalt the electrostatic inductive effect—namely, by converting upwards—an exhausted tube, devoid of electrodes, may be excited at a distance of several feet.

FACTS AND FIGURES ANENT ELECTRIC TRACTION.

COMPILED BY A. RECKENZAUN.

(*Continued from page* 744.)

NEW CONTINENTAL LINES AND PROJECTS.

Berlin.—A second project for an electric underground railway has been brought before the Berlin town councillors by Captain Immeckenberg. This line is intended to relieve the present crowded and ever-increasing traffic of the Friedrichstrasse.

Wurtemberg.—The town council of Tettnang passed a resolution on the 16th ult. to the effect that an electric railway should be constructed between that town and Meckenbeuren, the cost of which is to be borne by the municipality. The Oerlikon Works have already offered to undertake the task on very advantageous terms.

Halle.—The running of the electric cars has been resumed. The differences between the Allgemeine Elektricitäts Gesellschaft and the Postal authorities have been amicably settled, by the latter removing the telegraph and telephone wires beyond the influence of the overhead conductors of the tramway. There are now 18 cars in daily use, which are said to work admirably, and which are evidently very popular, the traffic on this line having increased 50 per cent. since the introduction of electric traction. In consequence of these successes, the tramway company have sold all their horses, which were kept in reserve until the telegraph and telephone difficulties were settled.

Leipzig.—The directors of the Leipzig Tramways Company, after visiting Halle and examining the electric system, have resolved to introduce a similar mode of traction on their lines.

Prague.—Messrs. Waldek and Wagner, of this city, have commenced on the permanent way for the electric railway which is to connect Teplitz with Eichwald, in Bohemia.

Prague.—The Austrian Minister of Commerce has sanctioned the construction of an electric railway leading from the Belvedere-Anhöhe to Bubenec. The design and contract are in the able hands of Mr. F. Krizik, of Prague.

Vevey-Montreux.—The balance sheet of the Vevey-Montreux Electric Company reveals the fact that the cost of traction on their tramway amounted to 3·48 pence per car kilometre. It will be remembered that in this case electric energy is produced by water-power, which is provided at a cheap rate. Nevertheless, the traction expenses are somewhat high, and approach the cost of animal traction very closely.

Sissach (Switzerland).—This electric railway has recently been opened for general traffic. It is 3¼ kilometres in length, narrow gauge, and almost level, the worst gradient being only 1·2 per cent. The line runs through a fine broad highroad. A sufficient waterfall furnishes power to a low-pressure turbine, which drives a 35-kilowatt dynamo, giving 700 volts with 50 amperes. The current is led to overhead conductors and returned by the rails. Fluid insulators fixed on wooden posts carry the conductors 5 metres above ground. The rolling stock consists of one electric locomotive, weighing 6,000 kilograms, four passenger cars, and four goods waggons. The locomotive is driven by two series-wound motors, each of which drives one axle, at a mean speed of 17 kilometres per hour. The fares are 2d. for the single journey and 3½d. return. The entire cost of line and equipment came to £15,200. The Oerlikon Works supplied the whole of the plant.

AMERICAN NOTES.

Mr. H. M. Whitney, the well-known president of the West End Street Railway Company of Boston, recently delivered several eloquent addresses before tramway authorities on the subject of electric traction on the lines under his control. He related that on some sections they could not make ends meet whilst traction was carried on with horses, and the more prosperous sections had to be charged with the losses. In order to remedy this evil they had to find out a new system of working, and that was the electric system. It took a deal of money to do it, but it has been found cheaper than horses. During the month of April of the present year the electric cars were operated at a less cost by 7 cents (3½d.) than the horse cars. They had run the big electric cars for 5 cents a mile less than the small horse cars, and that provided an increase in the carrying capacity in the proportion of 17 to 11 as an additional advantage. The experience which the West End Company had had with the electric system was exceedingly encouraging. The mileage run last year was 18,000,000, and the saving of 5 cents per car mile with the electric motors represents the sum of $900.000. "And what does that mean? Why it means the interest on a sufficient sum to pay for the cost of putting the plant in, and you have all the advantages of quicker transit and larger cars."

Horses v. Electricity at Louisville, U.S.A.

The following statement of earnings and expenses of the Louisville Railway Company during the year 1890, just published by the New York *Street Railway Journal*, will be found interesting in every particular, as they bear out statements which have appeared from time to time in the ELECTRICAL REVIEW relating to other economically worked lines:—

	Gross earnings.	Expenses.	Net earnings.
Horse cars ...	$1,009,598	$690,177	$319,420
Electric cars ...	128,897	66,462	62,435
	1,138,495	756,639	381,855
Net earnings as above			$381,855
Interest on all outstanding bonds			190,000
Surplus			182,855

Operating cost of horse-car lines, 68·30 per cent. of earnings.
" " electric " 51·56 " "
" " all lines 66·45 " "

Cable v. Electricity at Denver—1890.

	Gross earnings.	Operating expenses.	Net earnings.
Cable lines ...	$387,048	$273,743	$113,304
Electric lines 7 months	161,214	89,592	71,621

Operating expenses to gross earnings of cable lines, 77 per cent.
" " " " of electric lines, 55 "

These lines are owned by the Denver Tramway Company.

American Decision in Favour of "Earth Return."

Last month the Supreme Court of Ohio rendered a decision reversing that of the lower Court in the case of the Cincinnati Incline Plane Railway Company *v.* The City and Suburban Telegraph Company. The opinion given by the Judge was as follows:—

1. The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and in that view new and improved modes of conveyance by street railways are by law authorised to be constructed, and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets is subordinate to the rights of the public in the streets for the purpose of travel and transportation.

2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city, prior to the operation of an electric railway thereon, will not give the telephone company, in the use of the streets, a right paramount to the easement of the public to adopt and use the best and most approved mode of travel thereon; and if the operation of the street railway by electricity as the motive power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the condition created by the introduction of electromotive power upon the street railway.

3. When a telephone company, under authority derived from the statute, places its poles and wires in the streets of a municipality, and in order to make a complete electric circuit for the transmission of telephonic messages, uses the earth, as what is known as the "ground circuit," for a return current of electricity; and when an electric street railway, afterward constructed upon the same streets, is operated with the "single trolley overhead systems"—so called—of which the ground circuit is a constituent part; if the use of the ground circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in, and to the use of the ground circuit as a part of the telephone system.

(To be continued.)

THE ELECTRIC LIGHTING OF CARLSBAD.

[FROM OUR OWN CORRESPONDENT.]

THE electric works at the celebrated Bohemian watering-place, Carlsbad, on the projected electric lighting of which I reported to you last year, were successfully set in action on July 1st inst., amidst the eager sympathy of the inhabitants and the numerous visitors. I can give you now the following account of the technical details and the working of this very interesting installation.

According to the project accepted by the municipality, the electric central station was erected at Dönitz on ground belonging to the corporation near the water-works. The foundations were begun in June, 1890, and the buildings were so far advanced by the beginning of October that the boilers and machinery could be taken in hand. The engine house has an interior length of 25 metres and a width of 10·2 metres, covering consequently an area of 255 square metres. Four machines are set up, mounted on solid foundations of cemented masonry, accessible from below. Each consists of a steam engine, an alternating current dynamo, and a continuous current dynamo. The current of the latter serves merely to excite the field magnets of the accompanying alternating current machine. The engines are horizontal, with one cylinder each. At 360 rotations per minute each of them is capable of producing the work of 125 effective H.P., which will be required when the alternating current machine with the exciting dynamo is directly connected with the engine, and is worked at its full power.

The regulation of the steam engines is effected by flat slides driven eccentrically; the change of the acceleration is effected automatically by a spring regulator fixed on the engine shaft, which acts directly upon the eccentric and turns it according to the duty required from the engine. The lubrication of all the movable parts of the engine is effected from fixed points. For lubricating the slides and the cylinder there are used special apparatus (Mollrupp's patent), driven from the shaft by means of belting. For conveying the steam there are used wrought iron pipes, well covered and of 132 mm. diameter. They are placed along with the main pipe and in a spacious arched channel. The exhaust steam, a portion of which always serves for the preliminary heating of the feed water, is passed into the open air by means of pipes, of 237 mm. inside diameter, extending above the ridge of the engine house roof.

The alternating current machines, the discs of which are fixed on the axle of the engine, have 14 fixed induction bobbins, opposite to which revolves the magnet wheel, likewise armed with 14 magnets. The normal performance of such a machine is 80 kilowatts, corresponding to an alternating current of 40 ampères and a mean tension of 2,000 volts. The continuous current dynamos serving to excite the magnets of the alternating machines are connected directly with the shaft of the alternating machines by means of flexible couplings. They can furnish a current of 50 ampères and 110 volts. Both the alternating machines and the exciting dynamos are introduced parallel to each other, for which purpose there is employed a series of apparatus and instruments arranged on an oaken table, which takes up the entire width of the engine house.

The arrangement of the apparatus took place under inspection, and for the sake of greater simplicity, all the conductors were secured to the hinder side of the table. The regulation of the current, and the tension according to the fluctuating consumption of light, is effected automatically by means of a special self-acting regulator, which is influenced by an apparatus called an equaliser, and keeps the tension constant, whatever the strength of the current.

Up to these apparatus all the insulated wires are conveyed underground in a channel readily accesssible and well ventilated. At the above-mentioned table there branch off four uncovered wires of 8 mm. in diameter, which form the point of departure of the overhead lead, which conveys the high tension alternating current to the town.

The boiler-house covers an area of 200 square metres, and contains five boilers with safety tubes on the Babcock-Willcox patent, which have a total heating surface of 565 square metres, and are calculated to produce steam at a pressure of 8 atmospheres. The chimney for carrying off the smoke gases is 1·7 metre in diameter, and 47 metres in height. It is so wide, that in case of the enlargement of the installation, it can serve to discharge the smoke from the furnaces of seven boilers.

Two steam pumps, each of which can yield hourly eight cubic metres of water, serve to feed the boilers. To each is attached a preliminary heating apparatus, in which the water is warmed by the exhaust steam before it enters the boiler. To determine the quantity of feed-water consumed, two piston water meters, Schmidt's patent, are used. The arrangement for the water supply is such, that each pump can feed any of the boilers, for which purpose double pipes are provided. The steam supplied by the boilers is led into a main, which can be shut off with three valves. From this main there pass two trunk pipes to the distribution pipe in the engine house. Both the preliminary heaters, and all the pipes conveying steam, are covered with non-conductive material.

Of the four light machines which exist at present, three suffice for the normal work with the existing demand on the conductive net. In round numbers, there are connected 3,650 glow lamps of 16 normal candles, the arc lamps being recalculated as glow lamps according to their consumption of current.

Adjoining the boiler house, and connected with the engine house by a door, is a room of about 10 metres in length and 6 metres in breadth, which is to serve for the accommodation of a lighting installation to be procured in future. It is to consist of a slow speed, very economical compound steam engine with condensation and an alternating machine with its exciter, driven by belting, which is to take an equal share of the night work and the entire winter work, whilst in summer a heavy demand upon the electric works is made by most of the lamps in connection during a few hours in the evening, so that three light machines are required, each of 125 H.P. The demand for light during the seven winter months falls to an amount for which even one of the light machines is needlessly large, and consequently uneconomical in use. The case is the same for the service after midnight in summer at which time, except the lamps needed for public lighting, but few lights are in use. With reference to these circumstances, which spring from the local character of Karlsbad as a watering place, a smaller set of machinery must be adopted in order to secure economical working. But in order to determine its character and dimensions the results and experience of the first year's work have to be awaited.

Next to the small engine house is a workshop for repairs fitted with all the necessary plant and tools. For the store of coal there is a shed close to the boiler house and opening to the road. The removal of ashes and clinkers is effected through an underground passage.

For feeding the boilers there is used filtered water from the Eger, taken from the consumption reservoir of the water-works. In case this water supply should be interfered with in any manner, there is a well-shaped reservoir containing 12 cubic metres which can be filled from the water-works, and from which the feed pumps can draw the necessary quantity.

For the staff of the works there has been erected a special dwelling house, opposite to that provided for the staff of the water-works. It contains also the offices and stores, and a laboratory for measurements and experiments. It is duly equipped with the necessary apparatus and instruments for gauging the electricity meters, checking the consumption of current by the glow lamps, and the strength of light or the normal tension of the glow lamps.

The conduction of the current to the town is effected from the engine house to the house called "Schweitzerthale," on the Castle-Hill, by means of four light copper wires of 8 mm. in diameter, extended upon 110 lofty telegraph posts. At the house "Schweitzerthale" begin the underground wires by means of lead cables armed with straps which, as a protection against mechanical injuries, have been laid in channels lined and covered with brick-work. The primary cable carrying the high-tension current leads over the Castle Hill up to the Fountain Collonade. For the sake of safety, it has been laid in duplicate in a circular conduit of about 7 kilometres in length round the whole town on both banks of the Tepl. From this cable are supplied the different transformer stations distributed in the districts to be lighted according to the consumption of current. These stations serve for converting the current of high tension and relatively small quantity into one of great quantity and low tension, suitable for the arc and glow lamps in parallel arrangement. These transforming stations are partly placed in municipal buildings, partly in public spaces or in private forecourts in walled receptacles. Parallel to the primary cable, and in the same channel, there runs a secondary cable, from which the transformed current is distributed, by means of suitable apparatus, to the domestic fittings or to the arc lamps in the streets. Large consumers receive their current direct from the transformer stations, in which, according to the demand, two or four transformers may be placed in a parallel arrangement. These transforming stations, and also the connecting and distributing chests, contain the necessary appliances for securing and distributing the various compartments of the net, and they are so constructed as to be accessible at all times. As an advantageous feature of the transformer system, it must be mentioned that, notwithstanding the extremely long and ramified net, the tension remains equal in all parts of the lighted area, without any external regulation, however the consumption of the current may vary.

The streets are at present lighted by means of 80 arc lamps, partly fixed to brackets projecting from walls and partly supported on arches erected across the streets. Next autumn there will be installed, in addition, 100 glow lamps, the leads for which are already laid down, but the connection could not be effected in the spring, as there was not time for adapting the existing gas candelabra and brackets.

The private lighting comprises 40 arc lamps and about 2,500 glow lamps, divided among 65 installations. The issue of current for private consumption is effected according to measurement by electric meters, on the system of Ganz and Co.

In the construction of the entire installation care was taken to give full scope for possible extensions and enlargements. On this account the entire cable net and the aerial leads were made of considerably larger dimensions than would have been necessary for the present consumption. The net of cable is hitherto worked only to the half of its capacity. In the engine and boiler houses the installation can be extended by the addition of a fifth light machine, for which full provision was made in working out the plans.

As regards the total costs of the works they may, including the costs of the extension resolved upon by the representatives of the town whilst the works were in progress and the installations for municipal buildings amount to about 400,000 florins. Since July 1st the firm of Ganz and Co. have undertaken the preliminary working to show the perfect capability of the complete works. On the successful issue of these trial operations the works will be rented by the Joint Stock Machinery Company at Nürnberg (formerly J. A. Hilperl), which is also the proprietor of the gas works. By leasing the works to the above-mentioned company, by which the town comes into a proportion of the net profit, and by the coincidence of the expiry of the term agreed on with that for the gas agreement in 1902, the representatives of the town will have full control over the working.

THE INTERNATIONAL CONGRESS OF ELECTRICIANS AT FRANKFORT-ON-MAIN.

THE Council of the Electrotechnical Society of Frankfort have issued an invitation to electrical engineers and scientists of all countries to attend the Congress which is to be held during six days from September 7th to the 12th.

The manifesto just issued is supported by a large number of well-known men in the electrical world, and among those residing in this country we notice the names of Prof. W. E. Ayrton, Mr. Crompton, Dr. J. Hopkinson, Mr. Gisbert Kapp, Mr. A. Reckenzaun, Prof. Silvanus P. Thompson, and Sir William Thomson. The list is in alphabetical order, and it contains delegates from almost every country in Europe as well as America.

The programme promises a grand reception on the evening of September 7th, general and sectional meetings every day, a banquet, a promenade concert, a social entertainment in the marine exhibition with river illumination, a grand ball in the Zoological Gardens, a special performance in the Opera, several excursions, and a grand *fête* in the gardens of the Cur Park with fireworks. Among the papers to be read and discussed are the following :—

Carhart, of America : "The Substitution of Dynamo Machines for Batteries in Telegraphy." "Current Regulators for Dynamos."

Dolbear, of America : "Electrical Terminology."

Dolivo-Dobrowolsky, of Berlin : "Electrical Transmission of Power with Alternate Currents."

Epstein, of Frankfort : "Application of Measuring Instruments containing Iron for Alternate Currents."

Feussner, of Charlottenburg : "Material and Construction in Measuring Instruments."

Fröhlich, of Berlin : "Electro-acoustic Experiments." "Production and Use of Ozone."

Holborn, of Charlottenburg : "On the Magnetic Properties of Iron Alloys."

Hummel, of Nuremberg : "Direct Determination of Magnetisation and Currents in Iron Rings."

Kahle, of Charlottenburg : "On the Limits of Errors in Measuring Instruments with reference to Temperature, Residual Magnetism, &c."

Kareis, of Vienna : "Prevention of hearing conversation other than that intended through Telephones." "Prevention of Disturbances in Telephone Circuits through Powerful Currents." "Improvements in the Conductivity of Telephone Circuits."

Kohlrausch, of Hanover : "What shall be the most Useful Training for the Electrician ?"

Löwenherz, of Charlottenburg : "Introduction of a Uniform Screw Gauge for Electrical Instruments."

May, of Frankfort : "Rules for Wiring Buildings from the Standpoint of Fire Insurance Companies."

Meissner, of Göttingen : "Application of Lippmann's Capillary Electrometer for Cable Telegraphy."

Müller, of Hagen : "Arrangement of Accumulators for Large and Small Installations."

Peukert, of Brunswick : "Electricity Meters."

Rothen, of Berne : "Important Questions in Telephony."

Lectures on various electrical topics and papers have also been promised by Alioth, of Bâle ; Arnold, of Riga ; Dubois, of Berlin ; Ferraris, of Turin ; Görges of Charlottenburg ; Grawinkel, of Berlin ; Quinke, of Heidelberg ; and Slaby, of Charlottenburg.

Both from the scientific and the social point of view this congress promises a great deal that is interesting and enjoyable, and we doubt not that the attendance will be a very large one.

REVIEW.

The Rise and Extension of Submarine Telegraphy. By WILLOUGHBY SMITH. London: J. S. Virtue & Co., Limited, 26, Ivy Lane, Paternoster Row, 1891.

SECOND NOTICE.

The first cable from Dover to Calais, already alluded to, consisted of a No. 14 copper wire insulated with gutta-percha to half an inch diameter. The length was 25 knots, which was considered then a very large order. "The Gutta Percha Company could only cover short lengths of the wire at one time, and even then were not able to insure its being kept in the centre. The method of cleansing the gutta-percha, too, was very defective, and also there were to contend with many air holes and other imperfections, caused by the application of the gutta-percha so thickly in one covering." This is the author's account of the covering of this cable, and a little further on we learn about the early method of jointing this large size core. The gutta-percha having been removed for about two inches from either end of the wires, and the copper wires twisted and soldered, &c., "A suitable slice of plastic gutta-percha was then placed on either side of the joint, the whole pressed in a wooden mould, where it was kept under pressure until the gutta-percha was quite hard. The joint thus made resembled, when removed from the mould, a magnified cigar, some two inches in diameter and nine in length; it tapered at either end to the size of the covered wire over which it lapped." The modern finished joint is so well known that our readers can easily form a mental contrast between the two.

In the following year, 1851, the second Dover and Calais cable, consisting of four insulated conductors, was manufactured. The author remarks, "Insulating the copper wire with two instead of one covering of gutta-percha, and other improvements were no doubt steps in the right direction, but still the Gutta Percha Company had much to learn. This covering was very irregular, the lumps had to be spokeshaved before the wire could pass through the guage which corresponded with holes in the lay-plate of the twisting, or as it was called, the core machine, and in some places the copper wire was more or less eccentric. Want of adhesion between the two coverings was also frequent; while 'air-holes' and 'gutters' caused much trouble." But fancy "spokeshaving" a gutta-percha covered wire!

In jointing this core there was a slight improvement. "Two plastic bands of gutta-percha, one after the other, were applied over the copper joint and manipulated by hand to the required diameter, a warm iron "tool" being used along the seam, and at each end to amalgamate the whole."

There is, however, one point in connection with this cable the author does not mention, and that is that all four wires worked well and continuously from the time the cable was laid and for many years. The first interruption was, if we remember right, early in 1857, when the cable was severed by a vessel's anchor riding by it in a gale. The ship at anchor in the Downs, through stress, dragged her anchor, catching the cable and finally breaking it. After the cable was repaired it worked well, and continued to do so, but frequent repairs were necessary on account of breakages. The insulation of the original cable was low, but it must be remembered that in spite of the lowness of insulation the cable continued to work, and showed that the manufacture of the core was really better than what the description we have quoted might lead one to imagine.

The next point we have to note is that a strand conductor was first used in 1856 for a cable of 85 knots, manufactured and laid by Glass, Elliot & Co., from Newfoundland to Cape Breton. In 1857 a four-wire cable was laid from Cape Spartivento to Bona. Of this the author remarks "this was the thinnest covering of gutta-percha ever used for submarine cables." This cable was an unsuccessful one, for it became useless and was eventually abandoned; but we learn from the author the following remarkable facts: "Subsequent efforts to repair this cable showed that in places the gutta-percha had been sliced, apparently with a knife, along one side of the conductor, and tightly bound in its place again by well-tarred yarn. Thus ended an episode that will not redound to the credit of progress in submarine telegraphy."

There appears much of interest with regard to the gutta-percha core of the first Atlantic cable (1857), but we will only extract the following: "What had been long suspected was proved beyond doubt, namely, that a decrease of temperature increases the electrical resistance of gutta-percha, and that the amount of resistance depends upon the time it is under electrical charge, or, as it is now termed, polarisation or electrification. Age, too, has a marked effect in increasing its resistance."

The next improvement we come to is the application of compound to the gutta-percha. Mr. Willoughby Smith says of this—"In December, 1857, I first advocated the use of a compound composed of gutta-percha, Stockholm tar and resin, as an adhesive mixture; this was for application between each separate covering of the gutta-percha, instead of passing it through so quick a solvent as coal-tar naphtha, which had been the practice of the Gutta Percha Company ever since they commenced covering wires with more than one coating of gutta-percha. It was also suggested that the solid or strand conductor should pass through this mixture before receiving its first covering of gutta-percha. Experience soon proved that this mixture had not only good adhesive properties, but that wires covered with it had higher insulation than those covered in the ordinary way."

The first practical trial of the "compound" was in the four-wire cable, laid in 1858, between Dunwich and Zandvoort, in which two of the wires were compounded. The results were very satisfactory. By-the-bye, in this cable the several wires were distinguished by ribs in the outer surface of the gutta-percha, a suggestion of Mr. Latimer Clark's. Where stranded wires were subsequently used, it was found of advantage to pass the centre wire through compound, this prevented any water or moisture running up the ends.

Passing over the labours and experiments of the celebrated "Joint Committee," and many other data, we next come to the washing process, which was introduced in 1860, which is pointed out by the author as "a step in the right direction," and the introduction in 1862 of "white gutta-percha." From this time the manufacture of gutta-percha kept on steadily improving, and thoroughly reliable cores could be produced. This continued until in 1869, Mr. Smith made a great step in advance by introducing his "improved" core, which considerably reduced the inductive capacity. Of this he writes: "The only real advantage to be gained from the use of Hooper's core instead of gutta-percha, was its low inductive capacity. I therefore turned my attention to this point, and on February 4th, 1869, I informed Captain Sherard Osborn that by a slight alteration in the preparation of gutta-percha, its inductive capacity could be reduced 20 per cent. The company requested me to at once cover one knot on my proposed plan, and to ascertain what the real difference was between this and the material we were then using. For this purpose a knot length, the same size as the Brest and St. Pierre core was covered, and Mr. George Preece found it to be 19 per cent. lower in inductive capacity than that of the mean of the batch of coils he had last tested."

This was an improvement of the greatest value, especially with regard to the long cables which were being manufactured at this period. It meant either that a long cable could be manufactured to work at the same speed with a decreased cost, or with an increased speed at a similar cost. This improved core has been largely used in the various cables manufactured by the Telegraph Construction and Maintenance Company, Limited.

The book concludes with some useful points about jointing, &c., but the preface hints at the author saying something in the future about "gutta-percha." We hope that "time and opportunity" will allow of this subject being dealt with by him, as no one is more competent, or has more acquaintance with the material, than the author of the "Rise and Extension of Submarine Telegraphy."

Automatic Telephone Call Box.—The current issue of the *Elektrotechnische Zeitschrift* contains an illustrated description of an automatic telephone call box, by the use of which any one may, on passing a small coin through a slot, be able to ring up the exchange and communicate with a subscriber. This may interest a few English inventors of similar apparatus.

NOTES.

The Palermo Exhibition.—The contract for the electric lighting of this exhibition has been secured by Messrs. Siemens and Halske, of Berlin. The plant will consist of six dynamos of 60 kilowatts each. Five of these will be used for lighting purposes, while one will be employed in driving the electric motors in the exhibition ground.

Investigation of Accumulators.—On the 10th inst., in the central hall of the Berlin Electric Light Company in Hamburg, an assembly of about 40 gentlemen took place, there being represented among others the firms of Schwartzkopff, General Electricity Company, Siemens and Halske, Müller and Einbeck, and Profs. Vollert, Pinkert, and Kohlrausch. A commission was appointed to undertake comparative investigations as to the value of the Tudor and Correns accumulators.

Gold and Silver Extraction.—We are informed that Mr. E. Andreoli's process for the extraction of gold and silver from refractory ores by means of electrolysis and without preliminary roasting has proved to be so satisfactory, in London, where he treated only 1 or 2 cwt. of ore at a time, that his son has left for Swansea, where the process will be applied on a commercial scale, *i.e.*, on 1 or 2 tons, and he hopes soon to be able to give some details on the nature of ores treated, and on the percentage of gold and silver extracted in one single operation.

Electric Light at Naples.—A new central station is to be erected at Naples. The plant will consist, at present, of two steam engines, each of 100 H.P., each connected to a dynamo. The electrical portion of the work is being carried out by Messrs. Schuckert & Co., of Nurenberg, and the engines, which are of the high-speed vertical compound tandem type, are being supplied by Messrs. F. Tosi & Co., of Legnano, Italy. So many applications for a supply of light have been received that a further addition to the plant is under consideration.

Electric Tramways in Frankfort.—A new electric tramway on the overhead system was inaugurated in Frankfort-on-the-Maine on the 4th inst. It has been carried out by Messrs. Siemens and Halske, and starts from Opernplatz and terminates at the western entrance to the Exhibition. At the same time an accumulator car to run alternately with the others was placed on the line. The Frankfort "Waldbahn" is making experiments with a storage battery car with a view to ascertain whether that system is worth substituting for steam cars.

Personal.—We are asked to notify that Mr. E. Manville, M.Inst.E.E., has severed his connection with manufacturing companies, and is now carrying on exclusively the profession of consulting electrical engineer at Albany Buildings, 39, Victoria Street, Westminster.

Mr. Arthur Spain, late of Woodhouse and Rawson Electric Manufacturing Company, has been appointed electrician and superintendent over the glow lamp factory of the "firma Johan Bowdewijnse," at Middelburg, Holland, vice Mr. C. J. Robertson.

On Thursday last the *employés* of Messrs. King, Mendham & Co., electrical engineers and contractors of Narrow Wine Street and Fairfax Street, Bristol, had their annual outing, the place chosen being Ilfracombe. The party, numbering between 60 and 70, left Cumberland Basin by the *Ravenswood* at 9 a.m., arriving at their destination about 1.30 p.m., after an enjoyable passage. On landing they partook of a substantial luncheon, at which the health of the members of the firm was proposed in suitable terms. At 5.30 p.m. the return journey was commenced, and Bristol was reached about 10 p.m.

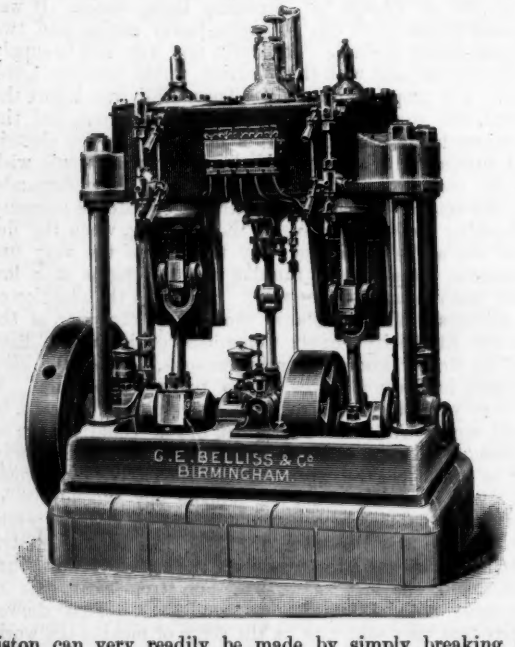
Electric Lighting of the Vienna Exchange.—It has been decided to introduce the electric light into the Vienna Exchange, and the contract for the work has been given to the Allgemeine Osterreiche Electricitäts-Gesellschaft.

Ships' Compasses.—The following letter reached us too late to place in our correspondence columns:—"My attention has been called to an article in the ELECTRICAL REVIEW of May 8th, 1891, at p. 579, in which the following words occur:—'No doubt Mr. Andrews will appreciate this opinion, which is endorsed by no less an authority than Sir William himself.' To prevent disturbance of the compasses, it is necessary that both wires should be insulated, and it is only when the outer sheath of the concentric wire system is insulated that it has any appreciable advantage over the one-wire system with ship return. If the outer sheath surrounding the insulated wire, is metallically connected with the iron of the ship, as I presume is the case in the Andrews system, because I see it stated that in it only the inner one of the two conductors is insulated, a very small proportion of the current will return by the sheath, and the remainder will spread far and wide through the hull of the ship. Thus the compasses will be very nearly as much disturbed as they would be on the one-wire system with ship's return. In the concentric system, however, a very moderate degree of insulation, such as mounting the outer sheath on dry wood, would practically annul the disturbance of the compasses.—WILLIAM THOMSON, The University, Glasgow, July 14th, 1891."

The Bradford Lighting.—At the monthly meeting of the Bradford Town Council, Alderman Priestman said, with regard to a question affecting the electric lighting works, that the present works had cost £35,000, and he was going to ask for £5,000 or £6,000 for increasing those works. It was proposed to put down one 300-horse-power engine, and two 80-horse-power engines. The works now were able to supply 3,500 amperes, and with this addition would produce 1,800 more. The proposal to light the Town Hall was before the council, and would probably soon be carried out, and the committee had a large number of demands for the electric light current. He apprehended that the council would wish that the committee should keep pace with these demands. The two smaller engines were required to obviate the necessity of running the larger engine in the morning, when the demand was at its minimum. By this means the very uneconomical proceeding of running a large engine at a low power was rendered unnecessary. He moved the adoption of the minutes. Mr. J. Galloway thought the chairman of the Gas and Electricity Supply Committee ought not to have used the word "economy" in his remarks, because the electric light had been a source of loss to the corporation. If the supplying of the electric light was a paying concern, he would support Alderman Priestman, but he could not do so at present. Alderman Priestman, in reply to Mr. Galloway, said he considered the expenditure on the electric light works was a wise one. He would not propose any expenditure of public money unless he believed it would be a wise expenditure. Up to 31st December, 1889, the loss on the electric lighting works was £1,079; during the half-year ended June 30th, 1890, the loss was £732; and from that date to December 30th, 1890, the loss was £315. That showed clearly that they were now on the verge of making the works pay, and from the facts and figures he had given to the council, he had not the slightest hesitation in saying that by the end of next year those works would be paying more than the interest on the money expended on them. He appealed to the council to complete the installation in the way proposed by the committee. He thought the committee was proceeding in the most economical course possible. There had been a complaint in some quarters about the committee not adopting the alternating current, and in answer to that complaint, he wished to state that the direct and continuous current was the one most favoured by authorities on the subject, and was the one which would probably be generally adopted in the future. The resolution was carried

Edison's Cosmical Telephone.—Some years ago, when the long distance telephone with a metallic circuit was being experimented with, Mr. Edison had control of a long line, and, says the *Scientific American*, he frequently heard very strange sounds in the telephone, which could have proceeded from no earthly origin. As sun spots were frequent at that time, he at once attributed these effects to solar eruptions, and afterwards, when experimenting at his iron mine in Ogden, N.J., with the magnetic needle, he found frequent, sudden, and very appreciable disturbances of the needle. These he attributed to the variable magnetic action of the sun. He then conceived the idea of surrounding the mine with a number of convolutions of wire which terminate in a telephone receiver and in suitable recording apparatus. The mine consists of an almost solid body of magnetic iron a mile long, 400 feet wide, extending into the earth to an unknown depth. This immense body of iron forms the magnet of the telephone, and 15 convolutions of wire mounted on telegraph poles surrounding the outcrop of this iron form the conductor of the telephone, and the terminals of this great coil extend to an observatory erected at one end of the mine. Mr. Edison is looking for some important revelations when this work is finished.

Electric Light Engine by G. E. Belliss & Co., Birmingham.—The accompanying illustration, gives a front view of one of this firms latest designs in dynamo engines for driving direct. At the Naval Exhibition, there are two of these engines at work for lighting the stands in the Camperdown Gallery, and for supplying the current to the search lights in the grounds. The one engine at the firm's stand No. 5,151 is coupled on to a Latimer Clark, Muirhead and Co.'s "Westminster" dynamo, capable of an output of 400 ampères, at 80 volts. The engine is compound, mounted on four steel columns which are attached to the bedplate. The guides are of special design cast with the bottom covers, so that an inspection of the inside of the cylinder and bottom of the



piston can very readily be made by simply breaking the steam joint. This does away with guide supports, stays and crossbars, which take up a lot of room, whereas, this type of engine is most easy for getting at to adjust the different parts both from front or back. The illustration shows the most important feature in this engine, *e.g.*, a single piston valve with single valve and eccentric rod, between the two cylinders, for giving steam to the cylinders, and this valve is controlled by crank-shaft governor gear fixed on to the H.P. crank web, thereby giving as complete a system of control as can be devised. The smaller engine at the General Electric Power and Traction Company's stand, is similar in design and drives one of their dynamos, of 150 ampères at 80 volts, running at 350 revolutions.

Our Boys and Girls, and what to do with them.—A very interesting series of articles are being published under this title in a Manchester weekly newspaper. The last article was from the pen of Prof. Nicholson, Demonstrator of Electrical Engineering in Cambridge University, and was entitled "How to become an Electrical Engineer."

Storage Battery Road at Dubuque, Iowa. — The Dubuque, Iowa, *Times* of a recent issue has an enthusiastic description of the new electric railway system of that city. Storage batteries are used to furnish the current, and the Dubuque paper claims that although single cars have been propelled for a short time by this system in other cities, "the Dubuque Street Railway Company is the first to equip its entire system with this latest and well-nigh perfect invention for the cheap and rapid transportation of the people." Nine cars are already in operation. A section of the floor of each car can be lifted up, disclosing the racks containing the accumulators. Each car is supplied with three incandescent lights. The electrical equipment was furnished by the Electro-Dynamic Company, of Philadelphia. The new system appears to give great satisfaction, and already representatives of other cities have visited Dubuque to inspect it. It has inspired the *Times* man to give utterance to the following eloquent description: "There is no tangle of overhead wires to spoil the view. But down the street, swiftly and silently save for the loud ringing of the warning gong, comes a beautiful car, skimming over the rails like a thing of life, yet so perfectly under the control of the "motorneer" that it can be brought to a standstill in half a car length. There is no rocky motion, no jarring. The cars run as smoothly and with apparently as little friction as a bird flies through the air."—*Scientific American.*

A Souvenir of Faraday.—The following letter, written by an old friend—long since dead—of Faraday and of Mr. William Crookes, F.R.S., may interest our readers. It came in reply to one in which Mr. Crookes asked Mr. Ward's assistance in preparing an obituary notice of Faraday for the *Chemical News*, and we have received permission to reprint it:—"Cornwall, *August 30th*, 1867.—Dear Crookes,—I should be proud indeed to be the spokesman of the chemical world in doing honour to Faraday's illustrious name on the occasion of his accession to immortality. But I should not dare to meddle with the laurels on so august a brow, without many days and nights of earnest research and meditation, to fit me for summing up, without omission, the splendid list of his imperishable labours. Only in this reverential spirit of earnest solicitude to do aright, which is, if I mistake not, the philosophical counterpart of prayer—of the religious feeling—could so solemn a duty be fitly undertaken. Only with the aid of other minds, kindred with Faraday's in genius, and filled with the light of his manifold discoveries, could any one man's mind become an adequate mirror to reflect the gigantic Shadow that has just passed to its place in futurity. For the present it is my fate to fulfil much humbler duties—which, having undertaken, I have no right to set aside. For duty must still be done, even when such appeals as yours set the wings of the caged lark trembling, and point him upwards to his barred out home. I must remain, therefore a unit among the millions whose hearts do silent homage to the illustrious dead, and can but watch from afar the starry coronation of which you invite me to be minister. So best, perhaps. For, after all, the name and fame of Faraday transcend all pomp of celebration, all burning words of praise. For whose the pen to weave so bright a glory as that electric fire which glows, through all the ages, round his brow, who first drew lightning from the loadstone, as Franklin drew it from the sky? In the moment of separation that little spark breaks forth—instantaneous yet eternal. It is but one vivid point of the radiance that encircles his name, yet of itself it is glory enough. From that spark a new branch of science has sprung, and under its creator's name, were it mine to carve his epitaph, these three should be the chosen words, 'Fulmen Eripuit Ferro!' —Ever yours faithfully, F. O WARD."

Berliner's Universal Transmitter.—By the expiry of the Edison patent on 31st inst., the Berliner universal transmitter is claimed to become free in England. It is not the original "one contact" Berliner transmitter (Patent 1,786—1884 which has lapsed), but the "universal" type of 1886, Patent No. 5,276, which is at present supplied, and which at the Frankfort Electrical Exhibition reproduces the sound from the Munich Opera House every evening in a marvellously distinct and clear manner. Messrs. O. Berend and Co. are the English representatives for the Berliner telephones, and as the patent 5,276 is said to be independent of any patent prior to 1886, it will be supplied after 1st of August by that firm.

Prof. Rowland on Protection against Lightning.—The *Baltimore Sun* recently interviewed Prof. Rowland, of the John Hopkins University, upon the subject of the protection of buildings against lightning. In the course of the interview, the Professor remarked that recent scientific study had swept away many of the old notions about conductors. The method now considered the best is to provide the buildings with metal roofs with an ample number of metal conductors reaching to the ground, which will receive and carry off the lightning. Copper was the best material, but tin or iron would answer the purpose, and he would suggest the placing of conductors at the corners of the buildings, so that all parts would be equally protected. In his opinion, one could safely class all patented lightning rods as being of little value beyond conducting rods that any man could put up himself. The simple underlying principle being that lightning would follow the best conductor. In speaking of places of safety, Prof. Rowland said that an iron bedstead would furnish probably a safe place during a storm, providing the ground connection was perfect.

Electric Lighting in Chislehurst.—At a meeting of the Chislehurst Local Authority, on Monday, the deputy clerk read a letter from the Provincial Electric Lighting Power Supply Company, Limited, of 5, Queen Victoria Street, E.C., stating that they intended applying for a provisional order for supplying electricity in Chislehurst parish. The clerk stated he understood that Mr. Willet (owner of the Camden Park Estate) was interested in the company who were taking the action, consequent on the development of the estate. Mr. Willet proposed that no gas should be used in houses to be built on his land, but each house be supplied with electricity from a central station. It was a serious question that if the company obtained the order they would exclude the authority from supplying electricity. The authority, however, could pursue the same course as the Bromley Local Board, who took out the order themselves. Mr. Clarence Smith said that what they must do was to prevent the company getting an order and not carrying it out. If it was a decent company with plenty of capital it was needless to oppose the application, providing the promoters agreed to supply the neighbouring property. The clerk said there were cases in which companies without capital or reserves had obtained such rights of large districts merely for the purpose of retailing them to others. On the motion of Mr. Clarence Smith, seconded by Mr. Charrington, it was resolved to make enquiries into the status of the applicants.

New Electrical Factory.—We hear that an important movement is now taking place in Birmingham, having for its object the establishment of an electric engineering concern on a very large scale. The works are to be fully equipped for the actual manufacture of all classes of electrical goods, including electric light and power plant, telegraph and telephone instruments, cables, and general material. The whole of a very large capital has been subscribed privately, and we believe that Mr. Slater Lewis, who is at present connected with the Birmingham Telegraph Factory, and who is so well known in the electrical profession, has been appointed managing director. A large and convenient site, adjacent to canal and railway, has been purchased, and active operations will be immediately commenced in the building of works specially designed and laid out for electrical work.

Ernest Scott & Mountain.—We have received from Messrs. Ernest Scott & Mountain a copy of the latest edition of their catalogue, containing illustrations and prices of dynamos, accumulators and other electrical machinery required for all classes of installation work. It also gives information of a useful character, such as the number of lighting hours per annum, instructions for managing dynamos, instructions for working accumulators, and also instructions for jointing cables. A table is likewise given of the carrying capacity of cables of different sections and the working load of engines.

The Accidents Imputed to the Electric Light in Paris.—At the meeting of the Paris Municipal Council, on July 8th, *àpropos* of a notice presented by M. Maurice Binder, on the subject of the different accidents imputable to the electricity companies or the gas company, the director of works declared that the administration had considered the question, which was interesting from the highest point of public safety. A committee composed of *savants* and specialists had, after numerous experiments, drawn up a report which would be submitted to the prefect of the Seine, with a view to his issuing some regulations on the subject. Prior to publication, these regulations will be submitted for the council's approval.

Mutual Telephone Company, Limited.—There are now 478 subscribers in communication through the Mutual Exchange. On July 31st the replacing of the present temporary transmitters by loud-speaking carbon ones will be commenced, and completed in about 10 days. An eminent firm of solicitors and patent agents have examined the Mutual loud-speaking transmitter, and report it as free of all patents owned by the National Telephone Company. A new revised list of subscribers has just been issued. On the 30th June, the Mutual Company's Manchester system comprised 421 miles of wire used as metallic circuits in use, and 150 miles spare, 11 miles of single wire, 90 standards, 14 poles, 81 cables, 134 junction boxes, and attachments to 430 buildings.

Seizure of Telephone Apparatus by the Société Générale des Téléphones in Paris.—In the REVIEW of June 5th, we gave some particulars of the friction which had arisen between the State, this Telephone Company, and the telephone subscribers, and the acquisition by the first named of the Roulez patent, so as to obviate using the company's apparatus. As will be seen from what follows, however, the company is now seizing the apparatus made according to M. Roulez's patent, alleging that they infringe the Edison patent. It may be remembered, says a Parisian contemporary, commenting on the matter, that the old telephone company, relying on a judgment given in its favour by the Court of Appeal, which conceded to it the exclusive monopoly for the manufacture of telephone apparatus fitted with the induction bobbin (Edison system), seized all the apparatus in course of construction at the makers to whom it had not granted licenses. The General Direction of Posts and Telegraphs then adopted the Roulez apparatus for its telephone posts, the working of which was assured by a bobbin of his invention. Now, the Telephone Company is again taking action. Alleging that the Roulez bobbin fell under the restrictions made by Mr. Edison in his patent, it is seizing at the makers all the Roulez apparatus, of which the construction had been begun, and this proceeding is expected to lead to further litigation.

The Electric Light for Dover.—Dover has at last advanced one step nearer to having the electric light introduced into the town for street and other illuminating purposes. Recently, upon the advice of the Town Clerk, the council decided not to put up an installation themselves, but to advertise for tenders, which was done, the result being that three tenders have been received, and a special private meeting of the members of the council is to be held at an early date. The matter will then be brought before the usual council meeting and decided upon.

Electric Lighting in Canterbury.—The Canterbury town council have resolved to defer electric lighting until they see how the Dover authority succeed with their scheme.

Saint James's and Pall Mall Electric Light Company, Limited.—The electric current sold during the quarter ending June 30th last amounted to £6,622, as against £1,991 for the corresponding period of last year.

Another Danger.—The circus processionists who ride on the top of gilded cars have had a fresh terror added to their lives in the telephone wires that cross the streets in provincial towns at low levels. Last week at Helensburgh the "Queen" had a narrow escape.

The Re-organisation of the American Westinghouse Company.—It is said that the re-organisation of this company will be completed within a few weeks. A meeting will then be held, in which final details of the scheme will be settled. The plan of re-organising the company has met with the full assent of the stockholders. In spite of the difficulties which this company has met during the past six months, the shops have not been idle a single day.

Pumping Machinery.—Messrs. Hayward, Tyler and Co., of Whitecross Street, London, have issued a new edition of Part C of their catalogue, giving particulars and prices of pumps, well frames, pumping machinery, steam fittings, and engineers' sundries. As a specimen of the many useful apparatus described may be mentioned a double-barrel tank fire engine, which would be found of great utility in any factory, as it is constantly ready for use. It is worked by hand, and has brass barrels and three-way cock for suction, so as to draw through a hose or from its own tank. The tank, which holds about 60 gallons, is of strong wrought iron, mounted on four wheels, with locking gear and drag handle, the handles being arranged to double out of the way when the engine is not in use. This form of engine was used at the South Kensington Exhibitions, for the protection of the buildings and contents. The prices are moderate enough to ensure their general adoption.

The Electric Light at Hove.—At a meeting of the Hove Commissioners last week, the Electric Light Committee recommended the adoption of the low pressure system as proposed by Mr. Crompton. The committee stated that they had considered the system recommended by the latter in comparison with the high pressure system with alternating currents, and in comparison with the different methods for construction of the distributing plant now in vogue, and were of opinion that the low pressure system, combined with storage from a single generating system, as recommended by Mr. Crompton, should be adopted for Hove. The site for the station recommended by Mr. Crompton would cost £1,215, and on the subject of plant the committee relied solely upon Mr. Crompton's recommendations. An amendment was proposed that before anything was done in the matter another engineer, Mr. Preece, be asked to consider whether this was the best mode of introducing the electric light into the town. The seconder of the amendment said he looked upon Mr. Crompton more as a special pleader for the low tension system than anything else. On the other hand, it was denied that the committee had been led entirely by Mr. Crompton's views, and it was contended that, whatever electrician might be consulted, he would tell them that for a large area the high tension system had certain advantages, but that for a moderate and compact area the low pressure system was the best. On a vote being taken, three members were in favour of the amendment, and the report of the committee was adopted.

Electric Lighting.—The arc electric lamps in the City Hall, Glasgow, have proved so unsatisfactory that incandescent lamps are to replace them.

Continental Telegraphs.—In the Lower House of the Austrian Diet, it was stated last week that there was a prospect of establishing, in the course of the year, a direct telegraph line connecting Vienna, Munich, Paris and London.

Father Thames Alight.—The Brush Company is fitting up an installation in the new floating swimming bath, now nearly completed, off the Embankment, between Charing Cross and Waterloo Bridges.

Society of Arts and the Chicago Exhibition.—The Council of the Society of Arts have been asked by the Government to undertake the duty of organising the British Section at the Chicago Exhibition, 1893, and are to be constituted a Royal Commission for that purpose. The formal documents constituting the commission will be issued very shortly.

Acton Hill Electrical Engineering Works Sports.—The third annual athletic sports took place on Saturday, 11th inst., in the grounds of "The Elms," Acton Hill, W. A lengthy programme was gone through, and was a great success. There was splendid weather, which, of course, added greatly to the enjoyment and success of the amusements.

The Edison Lamp Case in America. — A cablegram from America states that the United States Incandescent Lamp Patent case was, on Tuesday, decided in Mr. Edison's favour, an injunction granted, and accounts ordered. We shall anxiously await the opinions of the American technical press on this verdict, which will not be greatly approved of here.

Steamship Lighting.—On June 27th, the Naval Construction and Armaments Company launched from their yard at Barrow the first of three steamers building for the West Indian and Pacific Steamship Company. The new vessel, which was named the *West Indian*, will be propelled by direct-acting triple-expansion engines, and will have a complete installation of the electric light.

Gas and Electric Light in Madrid.—The Madrid Gas Company experienced a large increase in the sale of gas during 1890, the competition of the electric light notwithstanding. With a view, however, of the possibility of earning a higher dividend, the company has become financially interested in one of the electric light companies in that city. This is a sign of the times.

Direct-Driven Alternators.—It having been stated that for parallel running alternators probably required a flexible connection between themselves and the engines driving them, a trial was made the other day at Thames Ditton of two Mordey alternators directly coupled to Willans engines. The trial, which was made in order to convince some engineers interested in the question, was perfectly satisfactory and successful.

Electric Blowers for the Chilian Government.—Messrs. Shippey Brothers have secured the contract for fitting their new standard blowers on the war vessels now being constructed in France for the Chilian Government, the ventilation of which will be carried out on the same lines as those which were adopted and have proved so successful on the ss. *Baltimore* and others.

New Electric Tramways.—It is stated that the General Electricity Company, of Berlin, will shortly construct two new electric tramways, on the Sprague system, for the municipalities of Stockholm and Kiew.

Engraving on Metal.—A Russian electrician of the name of Kolomtarow is reported in the St. Petersburg papers to have devised a process of photographing and engraving on metals by means of electricity, rendering the etching method unnecessary. He is about to start for abroad to dispose of his invention.

"Units and their Nomenclature."—At the ensuing British Association meeting at Cardiff, it is proposed to hold in Section A, if possible in conjunction with Section G, a discussion on "Units and their Nomenclature," having special regard to the new electrical and magnetic units now becoming necessary for practical purposes.

NEW COMPANIES REGISTERED.

City of London Electric Lighting Company, Limited.—Capital, £800,000 in £10 shares. Objects: To enter into and carry into effect the agreements with the Brush Electrical Engineering Company, Limited, the Laing, Wharton and Down Construction Syndicate, and the City of London Electric Lighting (Pioneer) Company, Limited, mentioned in Clause 3 of the articles; to carry on in the City of London and in the district of the St. Saviour's (Southwark) District Board of Works, the business of an electric light company in all its branches; to construct, lay down, establish, fix, and carry out all necessary cables, wires, lines, accumulators, lamps, and works; to generate, accumulate, distribute, and supply electricity, and to carry on the business of electricians, electrical engineers, suppliers of electricity, and manufacturers of and dealers in all apparatus and things required for and capable of being used in connection with the generation, distribution, supply, accumulation, and employment of electricity. Signatories (with 1 share each); Sir David L. Salomons, Broomhill, Tunbridge Wells, and 89, Grosvenor Street, W.; F. W. Reynolds, 73, Southwark Street, S.E.; E. Lucas, 40, New Broad Street, E.C.: Duke of Marlborough, 3, Carlton House Terrace, S.W.; Earl of Suffolk and Berkshire, Charlton Park, Malmesbury; Hon. Alan Charteris, Lloyd's, E.C.; J. B. Braithwaite, jun., 27, Austin Friars, E.C. The number of directors is not to be less than three nor more than ten, the first to be nominated by the subscribers. Qualification, £1,000. Remuneration as follows: For the years 1891 and 1892, £1,000 per annum; 1893, £1,500; 1894, £2,000; 1895, £2,500; and for the year 1896 and three after, £3,000 per annum. Registered on the 11th inst by Ashurst, Morris, Crisp & Co., 17, Throgmorton Avenue, E.C. Office, 1 and 2, Great Winchester Street, E.C.

William Atkinson and Company, Limited.—Capital, £16,000 in £1 shares. Objects: To carry on the business of wholesale grocers, provision merchants, and importers, and to purchase, lease, or otherwise acquire or construct, alter, improve or develop lands, houses, buildings, engines, machinery, water, hydraulic, gas, electric, telephonic, and telegraphic power supply, and other articles and things whatsoever. Signatories (with 1 share each): W. Atkinson, 12, the Avenue, Sunderland; A. Lee, 20, Devonda Road, Herne Hill, S.E.; R. C. Nicholls, 121, High Street, Sunderland; W. Vertain, 5, Liege Terrace, Sunderland; W. Blackburn, 4, Frederic Street, Sunderland; W. Crake, 13, Kensington Terrace, Sunderland; A. J. Moore, 25, Fawcett Street, Sunderland. The first managing director is W. Atkinson, whose remuneration is to be fixed at the general meeting. Qualification: £500. Registered on the 13th inst. by Jordan and Sons, 120, Chancery Lane, W.C. Offices, 39, Castle Street, Sunderland.

Patents Royalties Company, Limited.—Capital £10,000 divided into 9,900 preference and 100 deferred shares of £1 each. Objects: To carry on the business of patents negotiators or agents, licensors and licensees; to advance money to inventors and patentees; and to carry on the business of electrical engineers, and makers of electrical apparatus, machines and instruments. Signatories (with 1 share each): J. H. S. Thomson, 90, Queen Street, E.C.; H. D. Hitchins, 262, King's Road, S.W.; J. Billie, 80, Queen Victoria Street, E.C.: A. B. Brandreth, 21, Finsbury Pavement, E.C.; E. George, 29, Chesterfield Grove, East Dulwich; A. Hill, 19, Thornhill Road, Barnsbury, N.; A. E. Edward, 90 and 91, Queen Street, E.C. The number of directors is not to be less than two nor more than five. Remuneration £100 per annum. Registered on the 11th inst. by W. A. Bryran, 8, Old Jewry, E.C. Office, 8, Old Jewry, E.C.

CITY NOTES.

The Eastern Telegraph Company, Limited.

THE following is a copy of the report presented by the directors at yesterday's meeting for the half-year ended March 31st, 1891:—

The revenue for the period amounted to £383,306 18s. 2d., from which are deducted £102,020 10s. 4d. for the ordinary expenses, and £53,144 9s. 6d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £2,274 12s. 9d. for income tax, there remains a balance of £225,867 5s. 7d., to which is added £78,195 6s. 5d. brought from the preceding half-year, making a total available balance of £304,062 12s. From this amount there have been paid—

	£	s.	d.
Interest on debentures and debenture stock ...	28,274	13	2
Dividend on preference shares	20,474	3	1
An interim dividend of 1¼ per cent. on the ordinary shares	50,000	0	0
	£98,748	16	3

Leaving a balance of £205,313 15s. 9d., from which £95,000 has been carried to general reserve. The directors now recommend the declaration of a final dividend for the year ended March 31st, 1891, of 2s. 6d. per share, and a bonus of 3s. per share, amounting together to £110,000, both payable on the 16th instant, free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The balance of £313 15s. 9d. shown at the foot of the revenue account is proposed to be carried forward to the next half-year. The revenue includes £33,283 4s. dividends and bonus for the half-year upon the Company's investments in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

The agreement with certain of the Australasian colonies for the reduction of rates between Europe and Australia having been concluded, the new rates were brought into operation on May 1st, last, and the increase of traffic is encouraging. The laying of the triplicate cable between Aden and Bombay, referred to in the last report, was completed by the contractors on April 19th last. The operations for duplicating the Suez-Suakim section, referred to in the last report, were successfully completed on the March 10th last.

The thirty-eighth half-yearly ordinary general meeting of this company was held yesterday at Winchester House, Old Broad Street.

The SECRETARY having read the notice convening the meeting, also the minutes of the previous meeting,

The CHAIRMAN (Sir John Pender, K.C.M.G.), addressed the shareholders, of which there was a large attendance. In going over the report, he commented upon the fullness of the same, from which, he stated, anyone could understand the movements of the company generally. There had been an increase in several items, while others show a decrease. The general expenses in London were £9,503, against £8,726, or an increase of £777. There was an increase of £2,526 in advertising and stationery, and the increased salaries and grants to some of the staff would also bring their expenses up a little. He stated that they had carried a smaller amount to the reserve fund this year than they did last. Their staff at different stations were now well provided for, and he thought that was a great point, as efficient men could only be kept by making them as comfortable as possible. The salary and wages had increased £146, while in office expenses there was a decrease of £22. There were other items, namely, rent and lighting, which, he said, it was unnecessary to mention specially. He referred to the Red Sea cable, from which they had succeeded in removing the weak parts. It had been working since the formation of the company, 21 years ago, and might still be efficient for a number of years, thereby increasing the security of telegraphic communication in the Red Sea. He stated that people used to say that 10 years was the life of a cable, then it came up to 15 years, but theirs had been working for 21. At the last general meeting they were informed that in anticipation of the largely increased traffic consequent on the reduction of the Australian rates it was decided to lay a triplicate cable between Aden and Bombay of such a capacity as to leave considerable margin of power. It had been the policy of the board to keep ahead of the carrying requirements, and it was satisfactory to know that the lowering of the rates had resulted satisfactorily, and fully justified the foresight and prompt action of the directors. Referring to the mileage of the company's cables, he said they had now a mileage of

26,098 miles as against 8,434 miles in the year 1870. This large addition had been done without in the slightest degree interfering with the dividends. It had been taken out of revenue, and at the same time they had added to the reserve. He thought it was a state of things which would be difficult to beat. Speaking of the development of African traffic, they had been approached by the Cape authorities on the subject of lowering the rates between England, and while they could not decide such an important matter without consideration, they would perhaps ultimately make some such arrangement. They had not yet recouped themselves for reducing the Australian rates, but he had no doubt that within 18 months they would be fully recouped for any loss they might have sustained. After referring to a recent trip to the Mediterranean and the satisfactory condition of the stations, he moved the adoption of the report, which was seconded by the Marquis of TWEEDDALE, and carried after a little discussion.

(A full report of the meeting will appear in our next issue.)

The Chili Telephone Company, Limited.

THE annual general meeting of this company was held on Tuesday, at Winchester House.

The SECRETARY read the notice convening the meeting, and the report, which was published in our last issue, was then taken as read.

The CHAIRMAN (Col. R. Raynsford Jackson) said: I have not much to say in support of the report, because all the main features of our business are fully dealt with in it. My object, however, will be to emphasise what is stated there, and perhaps to add a trifle on one or two points to add to its clearness. I will ask those who have reports in their hands to look at the statement of figures, from which you will see that the gross revenue of the company has increased from £26,310 to £38,711, or 47 per cent., and that the working expenses have increased from £15,996 to £19,506, only 22½ per cent. If you go through the calculation of the cost of working, it will be found to be from 61 per cent. upon the gross revenue to 50 per cent. The increase, therefore, to the gross revenue and the diminution of the expenditure had led to an increase in the net revenue in Chili from £10,314 to £19,205, or showing the very satisfactory increase of 86 per cent. These figures will make manifest the pleasing feature in the statement we have to put before you, *i.e.*, the great improvement of the value of our property in Chili. The increase in its earning power, and the fact that, but for an adverse circumstance over which we have no control, we should have been able to pay, wisely and prudently to our shareholders, a handsome dividend this year, in addition to adding a fair sum to the reserve. We have been obliged to diminish the profit of £17,094 made upon the working by £3,089, which is a reduction in the present value of our liquid assets in Chili due to the fall in exchange, that reduction being 25 per cent. If it had not been for that fall in exchange our earnings would be equal to 8¼ per cent. upon our capital. You will recollect that last year the chairman expressed regret that we were only able to pay 5 per cent., although in our prospectus we had held out the hope that we should be able to pay a dividend of 6 per cent. So far as our enterprise is concerned, we shall be able to exceed very much the promises of the prospectus, but for the fact that our prosperity has been—temporarily, I trust—interrupted by the civil war in Chili. Before I touch further upon the consequences of the civil war, I wish to point out that there has been an increase in the number of subscribers in Chili of 965, or 33 per cent., and I ask you to turn your attention to the table of expenditure shown in the report, from which you will see that we have spent during the year £35,136. Seventy-five per cent. of that amount has been expended in Santiago and Valparaiso alone. It has been spent on the entire reconstruction of the systems there, and on the assimilation of the property, which we took over from the National Telephone Company, with our own, and upon the trunk lines between the political and commercial capitals of Chili, which will eventually be of enormous value in the development of our systems in those two towns. The civil war in Chili has affected us in a variety of ways. In the first place, the President found it expedient to monopolise the use of our telephonic exchanges in the territory over which he maintains his rule, and we have received for the loss in which we were involved by that course of his, a certain, though not an adequate compensation. We trust, however, that when the civil war is over, we shall obtain ample compensation for all our losses arising out of the revolutionary war, from whichever party gains the ultimate ascendancy. In the territory controlled by the Congress party, our subscribers have not been dispersed. We are still working our own exchanges, and whatever damage has occurred to our property in those parts of the Republic in which the actual battle has raged, it is satisfactory to know that we are entitled to compensation, although we are unable yet to say what the actual loss is. Other consequences of the Civil War are the enormous fall in exchange, which has gone further since our accounts were made up, and the absence of all knowledge as to when the normal state of healthy government will be restored in Chili. Until then, we can form little idea of when and how far this cessation of war will restore our subscribers to us, and enable us to extend operations as has been done in past years. Our doubts upon this and other subjects leads us to the conclusion that although we have earned what under ordinary circumstances would have enabled us to pay a 7 per cent., it is not wise to declare a dividend of that sum under existing circumstances. If the war should cease early, and if the position of affairs in Chili should then be hopeful and satisfactory, it is quite possible that we should, even at an abnormal time, declare a dividend, for there is nothing in our articles to prevent us doing so. I have confidence that the shareholders will regard the course which the directors recommend to them as a wise and prudent one. The company is soundly based, and the shareholding body is a strong one, and I think our position is exactly one of those which justifies our thinking more of the future than of the present. I do not think it necessary, having touched upon these points, to do more than ask you to pass the resolution which I propose, "That the report of the directors, with the statement of accounts to March, 31st 1891, now presented to this meeting, be approved and adopted.

This was seconded by Mr. THOMAS GREENWOOD and carried unanimously.

Mr. GREENWOOD next proposed that the chairman (Col. Jackson) be re-elected.

This was seconded by Mr. ALEXANDER HENDERSON and carried unanimously.

The auditor (Mr. T. A. Welton) was then re-elected.

A vote of thanks to the chairman was proposed and carried.

The CHAIRMAN, in reply, said: I hope that next time we meet we shall do so under favourable circumstances all round, instead of in one important particular.

This concluded the business of the meeting.

Telegraph Construction and Maintenance Company.

THE half-yearly general meeting was held at the offices of the company on Tuesday last. The CHAIRMAN stated that there were no accounts to render at this meeting. Regarding the work carried out during the last six months he might say briefly that they had been employed principally since the commencement of the year in completing contracts entered into in 1890, namely in finishing the manufacture and in relaying the Eastern Telegraph Company's cable between Aden and Bombay, and the Eastern Extension Company's cable between Madras and Penang, both of which operations were successfully carried out in March and April last. Their factories were still at work in completing a contract for the Great Northern Telegraph Company. It was difficult to forecast a prospect of future cable contracts but they were able to say that their general current business continued to be satisfactory. He hoped the directors would continue to receive the confidence of the shareholders, in the belief that the directors were doing the best for the company. Theirs was a business of a nature that he thought it was in the interest of the shareholders of the company that the business should be left with the directors.

These observations were received unanimously as being satisfactory and the proceedings then terminated.

Edison and Swan United Electric Light Company, Limited.

THE fifth annual report states:—The business of the company has resulted in a credit balance of £72,905 4s. 7d., out of which the directors have appropriated the sum of £3,425 14s. 8d. to meet loss on realisation of dynamo account, taken over at the amalgamation, and £12,371 14s. 7d. has been absorbed by the payment of an interim dividend on the "A" shares at the rate of 7 per cent. per annum for the first six months of the year. The directors recommend the payment of the following dividends on the "A" shares, free of income tax, and to be distributed in accordance with Clause 87 of the articles of association:—(*a*) At the rate of 7 per cent. per annum for the half year ending June 30th, 1891 (making 7 per cent. for the year); (*b*) Three per cent. in completion of payment of arrears of cumulative preference dividend for the year ending June 30th, 1885; (*c*) Seven per cent. in payment of arrears of cumulative preference dividend for the year ending June 30th, 1886, which will absorb £47,719 10s. 7d., leaving £9,388 4s. 9d., which the directors have carried to the reserve fund, in accordance with Clause 89 of the articles of association.

The directors have granted licenses to several electrical firms and companies to manufacture holders and sockets for incandescent electric lamps under the company's patents. This branch of the business will increase as electric lighting increases, and will bring a satisfactory addition to the revenue of the company.

Mr. J. S. Forbes and Mr. F. R. Leyland retire from the board in rotation, and offer themselves for re-election as directors.

The auditors, Messrs. Welton Jones & Co., retire, and are eligible for re-election.

PROFIT AND LOSS ACCOUNT for the year ended June 30th, 1891.

Dr.	£	s.	d.
To Stock on hand, July 1st, 1890	56,266	8	10
„ Wages, purchases, &c.	56,362	19	6
„ Salaries, directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	15,270	6	7
„ Depreciation on plant, &c.	2,160	18	10
„ Balance	72,905	4	7
	£202,965	18	4

Cr.	£	s.	d.
By Sale of lamps, fittings, royalty on holders, &c. ...	143,229	14	11
„ Interest, &c.	427	12	0
„ Stock on June 30th, 1891	59,308	11	5
	£202,965	18	4

BALANCE SHEET, June 30th, 1891.

DR.	£ s. d.	£ s. d.
To Share capital:—		
5,000 "A" shares of £5 each, paid, allotted to the Edison Electric Light Company, Limited	25,000 0 0	
12,139 "A" shares of £5 each, fully paid, allotted to the Swan United Electric Light Company, Limited, ranking up to 5 per cent. for dividend on the amount credited as paid up, and afterwards equally, per share, with "A" shares partly paid	60,695 0 0	
89,261 "A" shares, £5 each, £3 paid	267,783 0 0	
23,564 "B" shares, £5 each, fully paid	117,820 0 0	
		471,298 0 0
The "B" shares are entitled to one-fourth of the profits, after a cumulative preferential dividend of 7 per cent. per annum has been paid on the "A" shares. (The preferential cumulative dividend of 7 per cent. amounted, on June 30th, 1891, to £82,491 12s. 4d.)		
„ Sundry credit balances		14,706 19 4
„ Reserve fund		12,689 0 3
„ Profit and loss as per appropriation account	69,479 9 11	
Less interim dividend at the rate of 7 per cent. per annum for six months ended December 31st, 1890, paid on February 20th, 1891 ...	12,371 14 7	
		57,107 15 4
		£555,801 14 11

CR.	£ s. d.	£ s. d.
By Cost of patents, goodwill, preliminary outlay, loss on working, &c., as per last balance sheet...	236,022 18 10	
Further expenditure thereon ...	2,041 15 5	
	238,064 12 3	
Deduct loss on realisation of original dynamo account taken over at the date of amalgamation, and heretofore reckoned amongst capital outlays ...	3,425 14 8	
	234,638 17 7	
„ Amount of "B" shares of this company, issued as per contra	117,820 0 0	
		352,458 17 7
„ Manchester Edison Swan Company Limited, £100,000 "B" shares at nominal cost		12,000 0 0
„ Freehold property		45,012 10 3
„ Plant and stock		83,188 11 0
„ Office furniture		231 3 6
„ Debtors		34,859 1 9
„ Investment in consols at cost		20,000 0 0
„ Cash at bankers and in hand		8,051 10 10
		£555,801 14 11

STATEMENT SHOWING THE PROPOSED APPROPRIATION OF PROFITS.

	£ s. d.	£ s. d.
To Amount transferred to capital account, to meet loss on realisation of original dynamo account taken over at the date of amalgamation and heretofore reckoned amongst capital outlays		3,425 14 8
„ Dividend for the year ending June 30th, 1891, at 7 per cent. per annum (of which £12,371 14s. 7d. was paid as interim dividend, on February 20th, 1891)	24,743 9 2	
„ Payment of the balance of cumulative preferential dividend on the "A" shares, for the year ending June 30th, 1885, at the rate of 3 per cent.	10,604 6 10	
And payment of cumulative preferential dividend on the "A" shares at the rate of 7 per cent. for the year ending June 30th, 1886 ...	24,743 9 2	
„ Reserve fund	9,388 4 9	
		69,479 9 11
		£72,905 4 7

	£ s. d.
By Balance of profit for current year to June 30th, 1891	72,905 4 7

The Direct United States Cable Company, Limited.

THE following is the directors' report for the six months ended June 30th, 1891, to be presented at the twenty-eighth ordinary general meeting of the Company, to be held at Winchester House, 50, Old Broad Street, in the City of London, to-day at 2 p.m.

Herewith the directors submit the usual statements of account for the half-year ended June 30th, 1891, which, with the half-year's accounts to December 31st last, presented at the ordinary general meeting on January 16th last, show the financial result of the fourteenth year's working of the Company. The half-year's revenue (subject to revision on settlement of the case mentioned below) after deducting out-payments, amounted to £37,352 19s. 5d., against £40,017 1s. for the corresponding period of 1890, being a difference of £2,664 1s. 7d. against the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £18,112 19s. 8d., leaving a balance of £19,239 19s. 9d. as the net profit of the half-year, making with £5,510 11s. 3d. brought forward from the previous half-year a total of £24,750 11s. For the corresponding period of 1890 the working expenses and other payments amounted to £17,616 5s. 8d. Three quarterly interim dividends of 3s. 6d. each per share, amounting to £31,872 15s., have been declared and paid during the financial year, and a final payment of 3s. 6d. per share is now proposed, making with the three interim dividends, 3½ per cent. for the year, being a total distribution of £42,497. The balance of £3,502 1s. on the revenue account is proposed to be carried forward. A break in the short section of cable, occasioned by a vessel's anchor, occurred on January 14th, about 278 knots from Halifax, and was repaired on March 28th, at a cost of £2,188 4s. 8d., which has been debited to the reserve fund account as heretofore.

In the action of the Anglo-American Company *v.* Paris-New York Telegraph Company, the question referred to the Council of State has been decided in favour of the Anglo Company, the French Company being ordered to pay the costs. The case will now go back to the Court of Appeal.

Pursuant to the provisions of the Articles of Association, two of the directors, viz.:—Sir John Pender, K.C.M.G., and William Ford, Esq., retire by rotation, and being eligible, offer themselves for re-election. Mr. John G. Griffiths, F.C.A., and Mr. John Sawyer, F.C.A., the auditors, retire pursuant to the articles of association, and offer themselves for re-election.

City of London Electric Lighting Company, Limited.

THIS company has been registered with a share capital of £800,000, divided into 40,000 preference and 40,000 ordinary shares of £10 each.

The Exploration Company, Limited, and the Electric and General Investment Company, Limited, authorised by the City of London Electric Lighting Company, Limited, invited applications for the 40,000 £10 ordinary shares above mentioned; payable, 10s. on application; £1 10s. on allotment; £2 on the 1st September, 1891; £2 on the 1st December, 1891; £2 on the 1st March, 1892; £2 on the 1st June, 1892.

The board of directors will be as follows: Sir David Salomons, Bart., chairman, Mr. Edward Lucas, Mr. F. W. Reynolds, the Duke of Marlborough, the Earl of Suffolk and Berkshire, Hon. Alan Charteris, Lloyd's, E.C., J. Bevan Braithwaite, jun., Esq., director of the Electric and General Investment Company, Limited, and of the Brush Electrical Engineering Company, Limited, the last four named being directors of the City of London Electric Lighting (Pioneer) Company, Limited. Chief engineer, Major-General C. E. Webber, C.B.

The company has been formed to undertake the electric lighting of the City of London and the district of St. Saviours, Southwark, District Board of Works. Contracts have been entered into with the City of London Electric Lighting (Pioneer) Company, Limited, the Laing, Wharton and Down Construction Syndicate, Limited, and the Brush Electrical Engineering Company, Limited, to take over concessions awarded them by the Commissioners of Sewers.

The Eastern Telegraph Company, Limited.—This Company notifies that the coupons on their 5 per cent. debentures, due August 1st next, will be paid on and after that date at the banking house of Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street, E.C. Coupons should be left at the bank three clear days for examination.

The Eastern and South African Telegraph Company, Limited.—This company announces the payment by warrants on August 1st next of interest for the half-year ending July 31st on their 4 per cent. mortgage debentures. The transfer books will be closed from July 28th to August 1st, both days inclusive.

Globe Telegraph Trust.—The directors announce a dividend of 3s. per share on preference shares and 4s. 6d. on ordinary shares, carrying forward £1,876.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the past week amounted to £4,883.

The City and South London Railway Company. Traffic receipts for the past week, were £692.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 10th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Company were £3,363.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 9.)	Closing Quotation. (July 16).	Business done during week ending July 16, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101 xd	98 —101 xd	98⅜	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	45½— 46½	45½— 46½	46	45
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84 — 85	84 — 85	85	84½
2,809,310*l*	Do. do. Deferred	Stock	10⅜— 11¼	10½— 11	11	...
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12 xd	11½— 12	12	11⅝
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107 xd	103 —107	...	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	2 11/16	2 9/16
63,416	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅜— 1⅝	1⅜— 2	1⅝	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	103 —107 xd	103 —107	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	17⅜	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3½— 4	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅝— 10⅞	10½— 10¾	10⅝	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¾— 15	14¾— 15	14 15/16	...
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15 5/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 — 110	107 —110	108¾	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	106¾	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 —15½	14⅝— 15½xd	15⅛	...
91,800*l*	Do. 5 p. c. (Aus. Go: . Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104 xd	101 —104	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104 xd	101 —104	102½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	108	106½
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104 xd	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104 xd	101 —104	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	101	100½
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3 — 4	3 — 4	3¼	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅛— 2⅜	2⅛— 2⅜	2 1/16	2⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3⅛— 3⅜	3⅛— 4	3⅜	3⅛
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛— 1⅜	1⅛— 1⅜	1⅜	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9½— 9⅝	9⅝— 9⅞	9⅞	9 13/16
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15 9/16	15 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 18⅝ xd	18½— 18⅝	18⅝	18½
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11 xd	10 — 11 xd	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	19 — 20	18½— 19½xd	19⅜	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40⅜	40
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 9⅝	9½— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅜— 10½	9⅜— 10½	...	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	5 — 5¼	4⅞— 5 xd	5⅛	4⅞
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½xd	13¼	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12¼— 12⅝	12½— 13 xd	...	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —106 xd	105 —107	105⅜	105
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16— 3/16	1/16— 1/16	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	8½	8
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6⅜— 7½	6⅜— 7½xd	7	6⅞
7,900	Do. do. do. 7 per cent. pref.	2	3½— 3⅝	3½— 3⅝xd	3⅝	3 15/16
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116½	115½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4 13/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	44 — 46 xd	45	44
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104 xd	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95 xd	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9 xd	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	95 — 98	95 — 98	96½	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	3½	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102xd	97 —102	99	...
64,174	Western and Brazilian Telegraph, Limited	15	11½— 11¾	11 — 11½	11½	11
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	...	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4⅝— 4⅞	4⅝	4⅝
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	105	104½
88,321	West India and Panama Telegraph, Limited	10	2½— 2⅝	2½— 2⅝	2 5/16	2 5/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10¼	10⅛
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —104	100 —104	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	4⅜— 5¼	4⅜— 5¼	5⅛	5

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 50—52.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4⅜—5¼.—Liverpool Electric Supply, £3 paid, 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅞—1⅛.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3⅛—4⅛.—Debentures 90—95.—Wards Electric Car, £10 paid, ⅜—1.

BANK RATE OF DISCOUNT.—2½ per cent. (2nd July, 1891).

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

THE transmission of power, in whatever way it may be effected, is one of the most important problems in applied mechanics. Strictly speaking, it enters into, and is, indeed, precedent to the application of power to all industrial operations. The power developed in a Lancashire mill engine only becomes of value to the spinner or weaver after it has been transmitted to the mules or looms by the agency of ropes, belts, pulleys, and other gear. Without such gear effecting the transmission, the power developed by the local steam engine would be as useless to the mill owner as the power which may be contained in a waterfall miles away. In either case transmission must precede the application of power; but whilst in the former case the problem of transmission is simple, and has to be attacked rather from the point of view of convenient subdivision, than with particular regard to efficiency (this being naturally high with properly designed gear); in the latter case the problem is of a much more difficult character, and efficiency, combined with moderate capital outlay, small working expenses, reliability and safety, become matters of first consideration.

We have thus to distinguish between two kinds of power transmission, the one taking place over distances reckoned by feet or yards, and the other over distances reckoned by thousands of feet, or even by miles. When we speak of the electric transmission of power, we tacitly assume that it belongs to the latter class, and refers to distances beyond the reach of the ordinary gear, such as shafting, cog-wheels, pulleys, and belts, employed for the subdivision and distribution of power within the walls of the factory; and it is in this generally accepted sense that I propose to bring the subject mainly before you. There are, however, cases where the application of electro-motors to special tools is either the most convenient or only possible method of applying mechanical power to the performance of certain operations, and it will, therefore, be necessary at least briefly to glance at that part of our subject which is not usually comprised within the title of these lectures, namely, the transmission of power over very short distances by means of electric currents. We thus distinguish between "long distance" and "short distance" transmission, the fundamental distinction between the two being that in the former, the transfer or transmission of power from one point to another, so to speak, in bulk, is our main object, whilst in the latter we rather aim at the subdivision and convenient application of power, in small quantities, at various points, and for particular purposes. I propose to consider long distance transmission first.

Broadly speaking, there are two ways in which we can transmit mechanical energy from one place to another. Let us assume, by way of example, that the primary source of energy is coal, and that the power derivable from this coal is required, not at the pit's mouth, but at a mill a certain number of miles away. In such a case, the obvious, and also the most economical, way of transmitting power is to carry the coal to the mill, and burn it under the boiler of the mill engine. Even if the distance between the pit and the mill is short, this method will be the best, provided there are no difficulties of transport. Suppose, however, that, although the distance is short, local conditions, such as great difference of level, bad roads, or total absence of roads, render the carriage of coal difficult or impossible, then we would establish our boiler and engine at the pit, generate the power there, and transmit it by wire rope, or in some other way, to the mill. In both cases we have transmission of power, but the methods are essentially different. In the first case we have transmitted, not mechanical, energy itself, but the thing from which mechanical energy can be obtained, namely, the coal, each ton of which represents so many stored horse-power hours. In the second case we have transmitted the energy itself in its kinetic or potential form. In popular language we might describe the process as the transmission of "live" power, as distinguished from the transmission of "stored" power, which takes place when we carry coal from the pit's mouth to the mill.

The most important sources of power in nature are corn, coal, and falling water. Under the term "corn," I comprise all vegetable foodstuffs suitable for conversion into mechanical energy, by means of horses and other animal engines; whilst the term "coal" naturally includes all kinds of fuel suitable for conversion into mechanical energy by some form of heat engine. The power derived from corn and coal is generally transmitted in the stored form; that derived from falling water in the live form, since the conveyance of water at a high level, or under considerable pressure, to great distances, necessitates the erection of very costly works. To prevent misunderstanding, I must here point out that I use the term "stored energy," as applied to water, merely in its colloquial sense. We speak of the energy stored in the water of a mill-pond, but, in reality, the energy does not reside in the water at all, but is an effect of its elevated position, and is, therefore, not comparable with the energy which is chemically stored in coal. Leaving, however, such distinctions on one side at present, we may regard water, which is being carried along horizontally, at a certain elevation, from one place to another, as the vehicle of so much stored energy, which we can obtain, in its live form, at any point at which we establish a water engine, through which the water passes in its descent to a lower level. If we carry water along in this way, it is not with the object of bringing the stored power to the point of application, but merely to secure the largest possible fall, and, therefore, a maximum of power with a given quantity of water. If it be necessary to transmit the power farther, the transmission is generally effected in the live form. Now let us see what position electricity occupies in relation to these primary sources of power in nature, namely, corn, coal, and falling water.

In the first place it will be obvious that, where electricity is the transmitting agent, we can effect the transmission both in the stored and in the live form. To see this clearly, we need only for a moment revert to our example of the coal pit and the mill. Instead of sending the coal to the mill to be converted into power there, we could burn it at the pit, and thereby generate steam to be used for driving a steam dynamo. The current from the dynamo we could utilise in charging a storage battery, and send this to the mill, where it would drive an electromotor, thus taking the place of the local steam engine. Here we have a system of transmitting energy in the stored form. On the other hand, if we do away with the batteries as a vehicle of energy, and connect the dynamo at the pit with the motor at the mill by a pair of insulated wires, we have a system of electric transmission of power in the live form. The latter system is that generally understood under the term "electric transmission of power," and therefore forms the principal subject of these lectures; but before entering upon it, I propose briefly to investigate the capabilities of electric transmission of power in the stored form.

As you all know, a sack of coal contains more stored power than a secondary battery of equal weight, and its carriage, whether by rail or road, is cheaper, easier, and requires less precautions than that of the battery. It is, therefore, quite obvious that, if the primary source of power is coal, and if there is no objection to the establishment of a steam engine at the place where the power is wanted, it will be more economical to carry the power there in the form of coal than in the form of batteries; not only because of the saving in carriage, but also on account of the smaller capital outlay, the smaller depreciation, and the avoidance of the loss of energy in the battery itself. But let us assume that the primary source of energy is falling water, then it is not so obvious at the first glance that its electric transmission in the stored form should be uneconomical. We cannot produce coal out of the energy of falling water, but we can charge batteries with it, and electricity would thus seem to offer a means of utilising a power of nature which would otherwise be lost. It might, perhaps, here be objected that electricity does not form the only means for utilising such a power, since there are various other ways in which power may be stored, a familiar example being compressed air. We might, therefore, also utilise the power of the waterfall for working an air compressor, and store the air under pressure in steel reservoirs, to be used afterwards for working air engines constructed similarly to ordinary steam engines. Many such engines are actually in use in Paris on the Popp system, though there the air is conveyed to them by pipes under pressure, and not in storage vessels, as would be the case in our example. There can thus be no doubt that the transmission of power by stored air is practicable, but the question is at what cost will it be effected, and can it compete with transmission by batteries? The answer to these questions depends on two factors, namely, the storage efficiency, and the cost of transport. By storage efficiency, I mean the ratio of the power put into and taken out of the apparatus which serves as the vehicle for the power. Batteries may now be obtained in which this ratio is about 80 per cent.; that is to say, for every 100 horse-power hours put into the battery, 80 horse-power hours can be taken out. The storage efficiency of compressed air is very much smaller. The most reliable data under this head are to be obtained from the paper which Prof. Kennedy read before the British Association in 1889, when he gave an account of experiments carried out at Paris on the Popp system. He found that the indicated efficiency with cold air was 39 per cent.; that is to say, for every 100 horse-power indicated by the compressing engine, 39 horse-power were indicated in the engine driven by compressed air as it came from the mains. If the air before being admitted to the engine was heated to 320 Fahr., the apparent indicated efficiency rose to 54 per cent., but as the heat energy thus supplied to the air requires the expenditure of fuel at the point where the power is wanted, the use of hot air really involves two methods of transmission—namely, that of power in the shape of air under pressure flowing through the mains, and that of power in the stored form contained in the fuel. To make the comparison with electric transmission of stored power a fair one, I must therefore take the efficiency of the Popp system when the air is not heated. A correction must, however, be made for loss of power in the mains. In the Popp system the power is transmitted in the live form by air flowing through pipes, and there is necessarily a certain loss on account of friction in the pipes and valves. As far as the friction in the pipes is concerned, this would not occur if the transmission were effected in the stored form by means of air carried under pressure in a reservoir, but, on the other hand, the loss by friction through valves would be greater, because it would be necessary to insert between the reservoir and the air engine a reducing valve, which would regulate the supply of air as the pressure falls, The loss of power due to this circumstance will probably be greater than the corresponding loss in the Popp system, where the pressure is constant; but as I have no experimental data to determine this point, I take the same loss as found by Prof. Kennedy—namely, 2 per cent., which makes the indicated efficiency nearly 40 per cent. The efficiency of the air engine he found to be, with cold air, 67 per cent., making the total efficiency of the system 26·7 per cent. By adopting air storage we could therefore obtain 26⅔ horse-power hours for every 100 horse-power hours indicated in the engine. Now let us see how the case stands with electrical storage. The efficiency of the steam dynamo, that is, the ratio of the electrical output to the indicated power, may be taken as 83 per cent., that of the batteries 80 per cent., and that of the motor at least 85 per cent., so that the total efficiency works out to quite 56 per cent., or more than twice that of the rival system. I have here assumed that the dynamo is steam-driven, simply because the only reliable figures I could obtain about compressed air referred to steam-driven compressors, but it is obvious that the comparison of the storage efficiencies of the two systems cannot be materially affected by the source of power, and will prac-

* Society of Arts Cantor Lectures, delivered February 16th, 1891.

tically be the same in the case under consideration, where the power is supposed to be derived from falling water. We see that in efficiency, at least, air storage is far behind electrical storage. Let us now inquire whether it is any better off in the other essential feature I have mentioned, namely, in the cost of carriage. The information available under this head is tolerably reliable as regards batteries, but this is not the case as regards air, stored under pressure. I know of no experiments made to determine accurately the weight of air reservoirs, and in the absence of such data I cannot do better than adopt the calculated figure given by Prof. Osborne Reynolds in one of his Cantor lectures delivered in 1888. According to this authority, the weight of the steel reservoir and air contained would amount to 300 lbs. for every horse-power hour so stored. Now the weight of a secondary battery filled with liquid, and provided with a tray and connections, all complete, does not exceed 100 lbs. per horse-power hour stored, that is only one-third the weight of an equivalent air reservoir. We see, therefore, that as regards efficiency, air storage is twice as bad, and as regards weight it is three times as bad as electric storage. Competition with it is, under these circumstances, obviously impossible, and we may therefore say that if the transmission of power from the waterfall to a distant point has to be made in the stored form, electricity is the only agent which need be considered.

Whether it would pay so to transmit power is a question which cannot be answered off-hand. As compared with the direct transmission of live power by means of a pair of wires, the cartage of batteries up and down the country will no doubt appear to be a clumsy device, but when we are investigating the different possible solutions of an important problem we must not allow any preconceived opinions of what is elegant or clumsy to influence our judgment, we must, in fact, judge each case on its own merits, and I propose to deal with the electric transmission of stored energy in this sense. The system of power transmission by storage batteries is actually in use, not, indeed, for long distance transmission pure and simple, as above defined, but still for transmission over distances reckoned by miles. I allude to the electric tramcars worked by storage batteries which are charged at a central depôt, and run for many miles before they require to be again charged. The object is not to carry a certain amount of power in bulk from one point to another, but to dispense whatever power is required for the propulsion of the car during the journey. We might, however, imagine the tramcar, instead of being occupied by passengers, to be loaded with storage cells in addition to those it carries for its own propulsion. Whilst the latter would gradually lose their charge in transit between the two terminuses, the former would arrive fully charged, and could be made to give up part of the power stored in them at the starting point. Here we have transmission of power in the stored form, but let us return to our example of the waterfall and the mill, and see how such a system might be put into operation.

At the waterfall we establish the necessary hydraulic works, and an electric station where the batteries can be conveniently charged. We further build a tram-line or railway, joining the charging station with the mill where the power is wanted, and we design the rolling stock with special regard to the safe and convenient carriage of the batteries to and fro. The train is fitted with electromotors, so as to make it self-propelling. A train load of charged cells is thus taken to the mill, and left there to work the electromotor which supplies power to the mill. During this process the batteries become gradually exhausted, and must be disconnected from the motor before they are quite exhausted, because we must allow a sufficient margin of power for taking the train back to the charging station. The economy of the whole system will evidently be the greater the less power is spent in the outward and home journey; and we might call "efficiency of transmission" the ratio of the power actually delivered to the motor, and that which might be so delivered if the battery were used for working a motor at the charging station itself; in other words, if the distance of transmission were nought. Say, for instance, that a total of 1,000 horse-power hours could be obtained from the battery if it were discharged immediately, and that the power spent in the outward journey amounts to 50 horse-power hours, then a further 50 horse-power hours will have to be spent in the return journey, and the power obtainable at the mill will only amount to 900 horse-power hours. The efficiency of transmission will, in this case, be 90 per cent. If we double the distance between the waterfall and the mill, the efficiency of transmission would be reduced to 80 per cent.; if we treble the distance, the efficiency would only be 70 per cent., and so on. The efficiency must naturally depend on the kind of road over which the transmission takes place; it will be small on a common carriage road, larger on a tramway, larger still on a railway, and largest on a canal. We can, for every arrangement, express the value of the system, as far as economy of power is concerned, in one of two ways. We can, if the distance is fixed, give the efficiency in the usual way as a percentage, or we can fix a standard percentage of efficiency, and ascertain the distance over which this standard is attainable in any particular case. I shall adopt the latter way of reckoning, as the more convenient for comparison with other methods for transmitting power, whether in the stored or live form.

First, as to transmission of stored power otherwise than by batteries. The only two methods we need consider are the carriage of corn and the carriage of coal, each combined with the use of a proper engine for converting the stored into live power at the other terminus of the line of transmission. In the case of corn, the starting point of this line is the field where the corn is grown. We there load it into suitable vehicles, and send it to the mill where the power is wanted. Since we are dealing now entirely with animal power, we must suppose the cartage to be effected by draft animals, say horses, and the conversion of corn into live power at the mill also by such animals. I need hardly say that, at the present time, no English mill-owner would dream of working his mill in this fashion by animal power, since coal is yet abundant, and a single steam engine is a far cheaper and handier instrument for producing and controlling a large amount of power than an equivalent number of horses. On the other hand, if power is required in small quantities, and in particular ways, then the horse will produce this power better, more cheaply, and more conveniently than the steam engine. It may seem absurd to work a large cotton mill by horse gear, but substitute for the mill a farm, and you see at once that the transmission of stored power to it, in the shape of corn, is a necessary part of the agricultural operations. Now the horses, in bringing the corn to the place where the power is required, perform work and must consume an equivalent amount of food. They also perform work in bringing the empty carts back again to the field to be re-charged. The ratio between the amount of corn delivered at the mill and the amount taken out of the field would therefore represent the efficiency of transmission. If this is to be 90 per cent., as in the case of electric transmission, we may take it that, for every 100 sacks of corn taken away from the field, the horses would eat on the outward journey (when the carts are heavily laden) 6½ sacks, and on the homeward journey (when they are empty) 3½ sacks, leaving 90 sacks of corn to be converted into live power at the mill. The distance to which we can thus carry stored power with a standard efficiency of transmission is a measure of the merit of the system, as far as economy of power is concerned.

The transmission of stored power in the shape of fuel is a parallel case. We load the coal at the pit's mouth into waggons, and haul them by means of locomotive engines to the places where the power is wanted. Part of the coal is consumed on the outward and homeward journey of the train, leaving the rest for the production of live power at the mill. If this amounts to 90 tons out of every 100 tons put on the train at the pit's mouth, we have again an efficiency of transmission of 90 per cent.

I have already mentioned that the exact distance to which we can carry power by either of the three agents here mentioned (namely, batteries, corn and coal), depends very much on the kind of road over which the transmission takes place. We might assume an almost infinite variety of cases, but, as our object is to obtain a rough general comparison of the different systems rather than exact figures for any one of them, I have assumed merely three kinds of roads, namely, a common carriage road, a tramway, and railway, and have calculated the distance to which power can be transmitted in each case with a loss of 10 per cent. The results of these calculations are given in the following table. The speed of transmission has been assumed at four, six, and twenty miles for road, tram, and rail respectively, when coal or batteries are the transmitting agents; and at four miles on all kinds of road when corn is the transmitting agent. In all cases I have assumed that the road is the best of its kind, perfectly free from gradients or curves, and that the traffic can be worked at the speeds mentioned without interruption. In reality, these conditions will of course not all be fulfilled; we have to make allowances for waste of power on gradients, curves, bad places in the road, for running at variable speed, and for stopping and starting. The distances given in the table are therefore throughout too large, but as our purpose is merely the comparison of the different systems, we may take the figures in the table as a rough indication of the merits of each.

TRANSMISSION OF STORED POWER.

Source of power.	Distance in miles attainable with 90 per cent. efficiency of transmission over—		
	Road.	Tram.	Rail.
Coal and steam engine	115	270	1,300
Corn and horse	52	170	440
Storage battery and electro-motor	4	10	26

You will see from this table that as regards efficiency the electric transmission of stored power cannot compete with the other two methods. A horse and cart carrying corn over an ordinary carriage road works with twice the efficiency of the electric locomotive taking batteries over a railway. The discrepancy is still greater if we compare the electric locomotive hauling batteries with the steam locomotive hauling coal. The latter can transmit power over a distance fifty times that over which the former can transmit power with an equal efficiency. On a tramline the distance over which we can transmit power with an efficiency of 90 per cent. is, according to the table, 10 miles, that is to say, if the whole load of the car is composed of batteries, we can run it 10 miles out and 10 miles home at an expenditure of 10 per cent. of the total charge of the batteries. Now let us see how this compares with the storage cars in use on passenger tramlines. The total weight of a full sized car is about 10 tons, made up somewhat as follows:—Car and propelling gear, 4 tons; batteries, 2½ tons; passengers, 3½ tons. If the 3½ tons represented by the passengers were utilised for additional storage cells, the car would run 20 miles with the loss of 10 per cent. of its charge; or it could run 200 miles if losing the whole of its charge. As there are, however, only 2½ tons of batteries instead of 6 tons, it can only run 86 miles. This is according to the table, and more than attainable in practice, for the reasons already stated. Experience has shown that storage cars can only run from 30 to 60 miles with one set of batteries, or half the distance stated in the table. If we apply the same reduction to all the methods of transmission, we find that the distances to which power can be carried electrically in the stored form with an

efficiency of 90 per cent. are 2, 5, and 18 miles over a carriage road, tramway, and railway respectively.

The efficiency of transmission is, however, not the only or even the most important consideration in the problem of transmitting power to a distance. The owner of a transmission plant cares nothing for any theoretical perfection in the way of high efficiency. All he cares for is the cost at which the power is delivered to him. All other things being equal, high efficiency will naturally reduce this cost, and in so far is an advantage, but in practice all other things are not equal, and to aim at high efficiency, regardless of other considerations, is the reverse of good engineering. It is no doubt gratifying to the engineer, if he can point to a transmission plant designed by him, to give some extraordinarily high efficiency; but if this result has been obtained by means of an exorbitant capital outlay and excessive working expenses, it will not be equally gratifying to his employer, the owner of the installation, who has to pay for its erection and working. It therefore becomes the duty of the engineer so to plan the installation that the cost of the power delivered shall be a minimum under any given circumstances.

We have seen that, as judged by the efficiency standard alone, electric transmission of power in the stored form is hopelessly behind the other two methods which we compared with it. Let us now see whether this is or is not the case if we judge the system by the more practical and, indeed, the only reliable test of cost. It is, of course, understood that in estimating the annual cost at so many pounds per horse-power delivered, we take into account not only the cost of coal burnt throughout the year, if we obtain the power by steam, or the rent for water, if we use a turbine, but also all other expenses which may properly be charged to the power account, such as wages for the attendants, petty stores, interest, repairs, and depreciation of plant. Estimated in this way, the cost of water-power will be found to vary between £2 and £8 per annum, the exact figure depending, of course, on the total amount of power available, the quantity of water, its fall and local conditions, which must largely influence the cost of the hydraulic works. The cases where water-power can be had at so low a price as £2 a year are exceptional; on the other hand, if we have to pay as much as £8 a year for water-power, it will seldom be worth while to transmit it electrically, or in any other way; and I shall, therefore, assume £3 and £6 as the limits of cost for water-power intended for electric transmission. The cost of steam-power, if produced by large economical engines, is generally taken at £10 per year; if produced by small, and therefore less economical engines, it may rise to £20, and even £40 per year. I shall further assume that in all cases the power is required for 3,000 hours during the year—that is, 300 work days of 10 hours. At the outset, it is clear that if we wish to transmit large parcels of power—say 100 horse-power and upwards—by storage batteries, we must be able to deliver the power at a cost not exceeding £10 a year; for, were the cost higher, it would obviously pay better to establish a local steam engine. I have already mentioned that a system of battery transmission can be made to yield 56 per cent. efficiency, if we allow 10 per cent. for the transmission itself. To deliver 100 horse-power we must, therefore, charge with 178 horse-power during a time equal to that during which the power is required. If, therefore, at the generating station the annual horse-power costs £3, the charge for power alone will be £5 6s. at the receiving station. To this must be added the cost of labour and the interest and depreciation of plant, which, in this case, consists of the generating dynamo, motor, batteries, and line of transmission, with its equipment of locomotives and waggons. The small storage cells, as now made, for lighting and power purposes, cost about £40 per horse-power; but let us assume that the larger cells, such as we would require, could be had for £30 per horse-power, then a battery to work a 100-horse-power motor would cost £3,330. In order to economise carriage, and to reduce the wear and tear of cells, it would be advantageous to have two batteries, one being charged while the other is at work. We have thus an initial outlay of £6,660 for batteries alone. The interest and depreciation on these will certainly not be less than 15 per cent., or £10 per horse-power. Add to this the cost of power at the generating station, that of labour and interest and depreciation on the electric machinery and the line, and you will see that it is quite impossible to compete with battery transmission against a local steam engine, if the power produced by the latter costs £10 per annum. But how does the case stand if the amount of power required is so small that it cannot be produced at this low figure. If we want only 5 horse-power, and if we produce it by a local steam or gas engine, we shall have to pay for each horse-power £20 to £40 per annum. Will it, in this case, pay to transmit by means of batteries the power produced by a large and economical steam engine at some central station? If we have to build a tramway or railway for this purpose specially it will certainly not pay; but let us assume that a tramway already exists, and let us investigate whether the company, which we suppose is working the line by storage cars, could afford to sell to a customer on the line power at a cheaper rate than he could produce by a local engine. Let us assume, by way of example, that the customer requires 5 horse-power for 10 hours daily. The battery to work a 5-horse-power motor will weigh about 2½ tons, and cost £170. The charging dynamo, motor, and regulating gear will cost about £150, so that the whole capital outlay, if we provide two batteries, will amount to £490.

Now let us see how such a system of transmission will have to be worked, and what the working expenses will be. I take, by way of example, five miles as the distance between the generating station, which may be the tramway depôt or a central electric light station on the line of tramway, and the delivery station. At either terminus we must have mechanical appliances for loading and unloading the batteries from the car, such as are generally used in connection with storage cars. Early in the morning a charged battery is put on the car, and run out to the delivery station, where it is unloaded and connected to the motor. The other battery, which has served during the previous day, is loaded on the car and taken back to the depôt to be charged up again. In this manner the car need only make one journey out and one journey home daily. As its speed may be very moderate, say from three to four miles an hour, the cost of running this car will be much less than that of a passenger car, which must stop and start every few minutes, and run at a higher speed. I take 3d. per car-mile as the cost of haulage, including the use of plant, and I further allow 2s. a day for labour in loading and unloading the batteries. The account of working expenses will now stand somewhat as follows:—

	£	s.	d.
Power at generating station at £10, allowing 65 per cent. total efficiency*	77	0	0
Haulage	37	10	0
Labour	30	0	0
15 per cent. interest and depreciation on batteries (£340)	51	0	0
10 per cent. interest and depreciation on electric machinery (£150)	15	0	0
Total annual cost	£210	10	0

This works out at £42 2s. per annum per horse-power delivered, and is therefore quite as high, if not higher, than the cost of power obtained by a small and uneconomical local engine. On the score of economy, there is consequently no advantage in transmitting power by storage batteries in the present case, where the distance of transmission is five miles. Had the distance been less, the working expenses would also have come out smaller, but not by any considerable amount. The only item in which we could save is cost of haulage, and if we neglect this altogether, we have still to pay £34 12s. per annual horse-power delivered. Battery transmission can therefore not compete against power produced by a local engine, even if the latter be of the rather uneconomical type which users of small power still tolerate. But how stands the case if, for some local reason, the employment of a heat engine of any kind is precluded? We have then the choice between electric transmission by means of batteries, and directly by means of a pair of wires. Which will be the more economical? As the dynamo and motor, except, perhaps, in the matter of voltage, will be the same in either case, the answer to this question turns upon the comparison of the batteries and line of wires. The first question to consider is whether our wires may, in the case of direct transmission, be carried overhead on poles and insulators, or must be put underground. If the former be the case, the line need not cost more chan £130 per mile; and I may at once mention that from the experience gained with various power transmissions, which I hope to bring before you, this item can be estimated with a fair degree of accuracy. As I shall have to deal more in detail with the cost and construction of live power transmission plants later on, I shall not enter into details at present, and must ask you to take my statements as to cost of line and cost of power transmitted as correct, though I do not now show how the account is made up. As regards transmission by wires placed underground, there is, as far as I know, no example of such an installation, and we can therefore not verify our estimate by reference to work actually executed, as we can in the case of overhead transmission. We are thus forced to calculate the cost of the line according to the data obtainable for electric light mains, and I take for this purpose an estimate made by Mr. Crompton in his paper on "Central Station Lighting," read before the Institution of Electrical Engineers, on the 12th of April, 1888. In this paper Mr. Crompton gave tables for the cost of underground mains of various types and sizes, and by reference to his tables I find that a main of the section required for the transmission of 5 horse-power, and insulated so as to safely bear a pressure of 1,000 volts, would cost about £670 per mile. We have now all the necessary particulars for making a comparison of the cost of battery transmission and direct transmission, the latter by both overhead and underground wires. The following table gives the result. The cost includes the charge for power at the generating station (taken at £10 per annual horse-power), and interest and depreciation on the plant, which is taken at 15 per cent. for the batteries and 10 per cent. for the line and electrical machinery.

TRANSMISSION PLANT FOR FIVE HORSE-POWER.

Distance of transmission in miles.	Annual cost per horse-power delivered if the transmission is		
	By batteries.	Direct.	
		Overhead.	Underground.
	£	£	£
1	36·1	22·8	33·6
2	37·6	25·6	47·2
3	39·1	28	60
4	40·6	30·6	74
5	42·1	33	87

* In this case the efficiency is the ratio of the power supplied to the charging dynamo to that obtained from the motor, and does not include power spent in transmission, being charged for in the account at 3d. per car-mile.

We see from this table that if there is no objection to an overhead line, the electric transmission of stored power by means of batteries cannot compete against the direct transmission of live power by means of a pair of wires, even if the distance is considerable. But in towns we cannot have, or at least we ought not to tolerate, overhead lines, and if we work with an underground line we find that for distances exceeding one mile the battery is a more economical transmitting agent than the wire. Here we have at last found a case where it will be advantageous to transmit power by means of storage batteries, but there are so many conditions attached to the case that the field of application of such a system must necessarily remain very limited. First, the power must be required, so to say, in small parcels; secondly, there must be a tram-line handy, and the customer must have facilities for loading and unloading the batteries and accommodating them on his premises; thirdly, there must be a charging station on the line having similar facilities; fourthly, the use of an overhead line must be excluded; fifthly, the distance must exceed one mile; and, finally, there must be some reason why a local engine cannot be used. I need hardly point out that a system of transmission fenced in by so many conditions cannot have any commercial importance. Thus far, the result of our investigation is entirely negative. We find that transmission of power by means of storage batteries, whether the power transmitted be large or small, is not so economical as other methods of transmission, and has, therefore, no commercial value for all cases where these other methods are applicable. If I have, nevertheless, devoted some part of this lecture to the subject of battery transmission, it was because the idea of distributing power, so to speak, bottled up in batteries, seems to have a fatal charm for many inventors. It is an old idea, but is always coming up again, and for this reason I thought it advisable to go a little into figures and show you how the case really stands. It might perhaps be objected that as no distribution of stored power by means of ambulant batteries has as yet been practically introduced, it is premature to give an opinion as to the possibilities of such a system. The idea of battery distribution of power is, as a matter of fact, entertained not only by amateur electricians, but also by practical engineers. As an example of this fact, I may quote a passage in a report written about two years ago by Mr. J. E. Fanning. This gentleman, reporting to the Cataract Construction Company on the question of utilising the power of Niagara Falls, says: "Power and lighting currents may be electrically transmitted to neighbouring cities, and possibly storage batteries may be electrically charged and recharged, and many times forwarded for use in surrounding cities." When writing this, Mr. Fanning had, of course, in view cheap water power, and probably canal transportation. If, at the same time, batteries could be made cheaper, lighter, and more durable than they actually are at present, then, but not until then, will they become commercially possible as transmitting agents in competition with other systems of power transmission. Taking batteries as we find them at present, their use as agents in the transmission of power is only justifiable in cases where the direct transmission by means of conductors cannot be employed; and this brings me to the consideration of the only case of the electric transmission of stored power which, as yet, has attained to practical importance—namely, the use of batteries for locomotive purposes.

Although electric tramcars come strictly speaking within the title of my lectures, I do not propose to consider them at any length, the reason being that this branch of power transmission alone, if treated in detail, would absorb all the time at my disposal. I shall, therefore, content myself in taking up the subject only so far as is necessary to show in a general way what is the present practice in this branch of power transmission.

We have in this country two very good examples of battery tramcars, the one being the cars now running in Birminghan, and the other the cars on the Barking Road line in the North of London. Of the former I have not been able to obtain much information, but of the latter I have by the kindness of Mr. Thomas Frazer, who superintended the erection and working of the plant, been able to obtain all the information required for my purpose. I am also indebted to Mr. Reckenzaun for information regarding his cars, which are in use in Philadelphia. The following table gives the principal data of these cars conveniently arranged for comparison and reference:—

STORAGE BATTERY TRAMCARS.

	Birmingham.	Barking Road.	Philadelphia.	
			Small car.	Large car.
Weight of car (in tons)	...	3·275	2·500	3·620
" " motors and gear (in tons)	...	1·360	·980	1·140
" " batteries (in tons) ...	2·850	2·400	1·770	2·450
" " passengers (in tons) ...	3·300	3·600	2·230	3·600
Total rolling weight (in tons) ...	10·50	10·63	7·48	10·81
Percentage of paying load	31·5	34	30	33·2
Number of cells	96	96	84	116
Maximum current	...	70	70	80
Maximum energy at battery terminals (E.H.P.)	...	19	14	23
Average energy at battery terminals (E.H.P.)	...	6	4·8	5·4
Maximum energy per 10 tons of rolling weight (E.H.P.)	...	17·8	18·7	21·3
Average energy per 10 tons of rolling weight (E.H.P.)	...	5·65	6·42	4·95

Taking the averages of the last two lines in the table, we find that for a car representing a total rolling weight of 10 tons, we require a battery capable of giving a maximum output at its terminals of 19 electrical horse-power, and a mean output of 5·6 electrical horse-power. It must, however, be noted that the latter figure applies to the time the car is actually in motion, and does not include the power wasted in starting. Mr. Fraser has made very careful observations of the power flowing out of the batteries during the whole of the time the car is in service, and found that the integrated power divided by time come to 7·33 electrical horse-power; that is to say, a motor taking from the batteries all day long 7·33 electrical horse-power, will take from the batteries the same amount of power that is actually taken under the intermittent work going on in the running of a tramcar. Of the 7·33 electrical horse-power, a good motor will yield about 6½ brake horse-power. Taking the efficiency of the batteries at 60 per cent., a figure by no means too low when we consider the very irregular nature of the work done by these batteries when in service, we find that the electrical horse-power of the charging dynamos required per car is about 12 electrical horse-power. The ratio between the indicated power of the engine and the output of the charging dynamo may be taken at 80 per cent., so that we shall have to provide engine-power at the rate of 15 indicated horse-power for every car, provided the engines are worked for the same number of hours that the cars are in service. If the engines are worked for a longer time, say by night as well as by day, a corresponding reduction in the total indicated power of the station can of course be made.

Returning now to the subject of the cost at which stored power can be retailed by electric transmission to small consumers, let us briefly glance at the rival system, namely, the distribution of small parcels of live power from a central electric light station. One hears it often stated that the supply of power, and not that of light, must become the chief business of such stations. The argument in support of this view is somewhat as follows:—The demand for light is very uneven, being less than a tenth of the capacity of the station for many hours during the day, and rising very rapidly towards evening. The period of large demand comprises only a few hours, and during that time the engines work with great economy. During the remainder of the day the economy is less, and, in fact, the greater portion of the coal bill, cost of attendance, and interest on the capital outlay is chargeable to light running. If, therefore, by the sale of power, we could keep the central station plant economically working during the whole of the day, the increase in the working expenses would be slight, but the increase of revenue would be very considerable. This argument is perfectly sound, but it has the rather serious defect that it will not convince the very people from whom this large increase of revenue is to be obtained; for, let us see what it means to the user of power. As you know, electric current is supplied from central stations at a charge varying from 4½d. to 8d., and even 1s. per Board of Trade unit. The usual charge in London is about 7d. Now, suppose a small manufacturer, requiring only a few horse-power, determines to discard his small steam or gas engine, and put up an electro-motor, to be worked by current from a central station, what will the power cost him? This, of course, depends on the time—that is, the number of hours in the year during which he requires power. If he has a small factory, in which work is steadily going on day by day, you may estimate that the power will be required during 3,000 hours per annum. It is now very easy to calculate the annual cost of each brake horse-power. Allowing £1 10s. per horse-power for depreciation and interest on the motor, and £1 for petty stores, we find that, at 7d. per unit, the annual horse-power comes to £75. With current at a different price, the cost of power will be accordingly altered, as shown in the table:—

POWER DERIVED FROM A CENTRAL STATION.

Cost of Board of Trade Unit.

d.	d.	d.	d.	d.	d.	d.	d.
1	2	3	4	5	6	7	8

Cost of Annual Brake Horse-power for 3,000 *Hours.*

£	£	£	£	£	£	£	£
12·9	23·3	33·5	43·9	54·2	64·5	75	85·4

It is clear, from this table, that the small user of power will only use an electro-motor if he can get current at about 3d. per unit, and unless electric light companies can supply at this price (which, at the present time, does not seem likely), there is no prospect of supplying electric power to small factories wanting the power continuously. Another disadvantage is that the demand for power must, in winter at any rate, overlap the demand for light, thus requiring the erection of additional plant. If, however, the power is only required intermittently, then the electro-motor is by far the cheapest instrument for producing it, not only as regards first cost, but also as regards working expenses. There are many small trades in which power is wanted only for a few hours during the day. If, for instance, the actual running time of a lathe is two hours daily, then the cost of the annual horse-power, with current at 7d., would only be £15, a figure which cannot be touched by either steam or gas. There is the further advantage of having the power always ready. There is no need to get up steam, look to the feed pump, open cylinder cocks, turn the engine over the centre, and generally do the dozen little things which are required in starting an engine. With a motor, all that is required is to turn on the switch when the power is wanted, and to turn it off again when the job is done. For domestic purposes, again, nothing could be more handy and economical than electric power supplied from a central station. I have here a collection of appliances, for the loan of which I have to thank the Keys Electric Company, and I can show you how easy and convenient it is to apply electric power to small domestic machinery.

I have in the present lecture dealt with what may be termed general questions of engineering policy rather than with technical details, and I am afraid you will have found the financial parts of the lecture rather a dry subject. The question of cost is, however, of the utmost importance in engineering work, and it was therefore necessary to give it some consideration. In the remaining two lectures I shall be able to turn to the more interesting parts of our subject, and bring before you some of the scientific principles and technical details relating to the electric transmission of live power over long and short distances.

LEGAL.

City and South London Railway Company v. The London County Council.—This case came before Lords Justices Lindley, Fry and Lopes, on Friday last.

This appeal raised an important question, involving the right of the Electric Railway to keep its station at Newington in its present position, part of the building being erected beyond the general line of houses in Kennington Park Road. It was an appeal by the London County Council from a decision of a Divisional Court (reported in 7 *The Times* Law Reports, p. 462) allowing an appeal from an order of a magistrate directing the demolition of part of the station. The City and South London Railway Company were empowered by their Acts of 1884 and 1887 to construct an electric railway from King William Street to Stockwell. Section 4 of the Act of 1887 provided as follows:—"Subject to the provisions of this Act, the company may make and maintain in the lines and according to the levels shown on the deposited plans and sections the subway hereinafter described, with all necessary approaches, tunnels, shafts, hydraulic lifts, buildings, works, machinery, and conveniences connected therewith, and may enter upon and take and use such of the lands delineated on the deposited plans and described in the deposited book of reference as may be required for that purpose." By section 27 the company were required not to make any approach to the subway or any permanent tunnel, shaft, or other work, in such a manner as to interfere, after the completion thereof, with the carriage or footway of any street, nor to make more than two temporary shafts or openings in the surface of any street in the parish of St. Mary, Newington, without the consent of the Metropolitan Board of Works and of the vestry of the parish. The company acquired land at the corner of New Street and Kennington Park Road within the line as shown in the plans, and constructed thereon two shafts, in one of which was a spiral staircase, and in the other hydraulic lifts affording access to the underground platforms. Over and adjacent to these shafts the company erected a station, part of which was erected beyond the general line of buildings, in contravention of the Metropolis Management Act, 1862. This part of the station contained the entrance door, which opened on to the pavement of the Kennington Park Road, the booking offices, part of the waiting room from which the lifts were entered, and another room. While the buildings were in course of erection the company were informed by the district surveyor that their buildings projected beyond the general line of buildings, and that unless the company obtained the consent of the London County Council to such erection they would be proceeding therewith at their own risk. The consent of the London County Council was never obtained. On June 27th, 1890, the superintending architect of the London County Council, in pursuance of section 75 of the Metropolis Management Act, 1862, as amended by the Local Government Act, 1888, certified that the buildings of the railway company had been erected beyond the general line of buildings. If the company had acquired certain other lands, as they were entitled to do, adjoining those which they actually acquired, they could have erected a building equally convenient for the purposes of their undertaking within the building line. The magistrate found, as to the necessity and convenience for the company's said building, that a station building at the corner of New Street was necessary, and convenient for railway purposes; that the station building, without reference to the provisions of the Act of 1862 (25 and 26 Vic., c. 102, s. 75) was a reasonably convenient building; that it was, however, not necessary for the purposes of the railway that any part of the station buildings should be erected beyond the general line of buildings; and that it was convenient only in that the company saved expense by acquiring less land. The magistrate held that the company were not entitled to build as stated, and ordered the demolition of so much of the building as was beyond the general line of buildings in Kennington Park Road. The company appealed. The Divisional Court (consisting of Mr. Justice A. L. Smith and Mr. Justice Grantham) considered that the provision of the special Act which authorised the company to erect buildings necessary for their undertaking impliedly repealed the general Act, and they accordingly allowed the appeal. From this decision the London County Council appealed.

Mr. LUMLEY SMITH, Q.C., and Mr. CUNNINGHAM GLEN appeared in support of the appeal, and contended that the special Act could be read consistently with the general Act. The power conferred on the railway company was only to make necessary buildings and approaches, and it had been found by the magistrate that it was not necessary to erect the station at this particular spot. A thing was not necessary merely because it was economically convenient. "Reg. *v.* Wycombe Railway Company" (L.R., 2, Q.B., 510), "Fenwick *v.* East London Railway Company" (20, Eq., 544), "Pugh *v.* Golden Valley Railway Company" (15, Ch.D., 330).

Mr. FINLAY, Q.C., and Mr. W. GRAHAM, for the railway company, were stopped.

The court dismissed the appeal.

LORD JUSTICE LINDLEY said that the question turned upon the joint effect of the Metropolis Management Act, 1862, and the City and South London Railway Act, 1887. The general Act which was first in point of date prohibited in general terms the erection of buildings beyond the building line of the street, except with the consent of the Metropolitan Board of Works, whose power had since been conferred upon the London County Council. The question was whether the special Act of 1887 had authorised the railway company to build a station in the way in which they had constructed it, some portion of it projecting beyond the building line. The view of the Divisional Court was that upon the true construction of the special Act it was impossible to read that Act so as to make it consistent with the general Act. The question turned upon the construction of section 4 of the special Act, and particularly upon the meaning of the word "necessary" and the expression "as may be required for that purpose" as used in that section. In his lordship's opinion the view of the Divisional Court was right. "Necessary" meant necessary for the undertaking without reference to the locality provided the buildings or other authorised works were within the lines shown on the deposited plans. The word "as may be required for that purpose" implied that the company were to be the judges of what they would require. The findings of the magistrate were important. He found, first, that it was necessary and convenient that a station should be erected at the corner of New Street, but he found further that it was not necessary for the purposes of the railway that any part of the station should be erected beyond the building line. Upon that finding the controversy arose. If the Court adopted the construction which his lordship had put on section 4, and were to accede to the contention of the appellants, that would be equivalent to telling the railway company that, though they had erected a building which was necessary for the purpose for which they were authorised to acquire land, it was nevertheless open to the County Council to dictate to them (the railway company) precisely where the building was to be and how it was to be erected. In his lordship's opinion, provided that the building was necessary for the undertaking, and was within the scheduled lands, it was no answer for the County Council to say that the building might have been erected quite as conveniently for the purpose of the undertaking somewhere else. The matter was made still plainer by certain limitations upon the powers of the railway company in the Act itself. The powers conferred by section 4 were declared to be subject to the provisions of the Act, and by section 27 the railway company were expressly prohibited from interfering with the street without the consent of the Board of Works; but that section contained no prohibition as to projecting beyond the building line. The appellants had relied upon several cases, of which "The Queen *v.* Wycombe Railway Company" was the first; but those cases turned upon the necessity of the thing to be constructed. The Court having found in this case that a station was necessary there was no authority for compelling the company to build their station on any particular spot. The appeal failed.

LORD JUSTICE FRY agreed. The special act empowered the railway company to take and use such of the lands delineated on the deposited plans as might be required for the purpose of erecting a station, the magistrate having found that a station was necessary. These lands were partly within and partly without the building line in Kennington Park Road. It was obvious that section 4 was inconsistent with the general Act unless it were to be read subject to a proviso that nothing contained in that section should enable the company to build on land within the lines on the deposited plans unless it was also within the building line. His Lordship did not think that the special Act ought to be so altered in order to make it consistent with the general Act.

LORD JUSTICE LOPES concurred.

NEW PATENTS—1891.

9,652. "Improvements in the production of copper tubes by electrolysis." A. WATT. Dated June 8th.

10,612. "Electrical transformers for rotary phase currents." SIEMENS BROTHERS & CO., LIMITED. (Communicated by Siemens and Halske, Germany). Dated June 22nd.

10,613. "Glow lamps for rotary phase currents." SIEMENS BROTHERS & CO., LIMITED. (Communicated by Siemens & Halske, Germany.) Dated June 22nd.

10,636. "Improvements in electric telegraph printing." M. A. WIER. Dated June 23rd.

10,664. "Improvements in or connected with the insulation of electrical conductors." H. T. HARRIS. Dated June 23rd.

10,697. "An improved method of and apparatus for protecting dynamo-electric generators and other apparatus from the effects of lightning." H. H. LAKE. (Communicated by the Thomson-Houston International Electric Company, United States.) Dated June 23rd. (*Complete.*)

10,703. "Improvements in the manufacture of the arms or attachments of telegraph poles for carrying insulators." H. C. JOBSON. Dated June 23rd.

10,704. "Electric directing apparatus for use in cabs, carriages, or on boats, railway trains and the like." A. DOUGLASS. Dated June 23rd.

10,729. "Dynamo or electro-motor ring armature construction." G. B. LUCKHOFF and E. H. HUNGERBUHLER. Dated June 24th.

10,762. "Improvements in call boxes or like electrical communicators." G. T. CASHMORE. Dated June 24th.

10,778. "Improvements in electric arrangements and apparatus for locking railway signal and point levers, also applicable for other purposes." J. A. F. ASPINALL and H. A. HOY. Dated June 24th.

10,787. "Improvements in materials for insulating electric conducting wires, and for carbons and incandescent filaments for electric lighting." G. A. CANNOT. Dated June 24th.

10,821. "Improvements in firing guns by electricity." W. BALCH. Dated June 25th.

10,832. "Improvements in electrical transformers." WOODHOUSE and RAWSON UNITED, LIMITED. (Communicated by E. Preschlin, Germany.) Dated June 25th.

10,838. "Improvements relating to the lighting of trains by electricity." W. BREW. Dated June 25th.

10,839. "Improvements relating to dynamo-electric machines, and to electromotors." W. BREW. Dated June 25th.

10,877. "Improvements in or connected with means of connecting ropes or cords, and hauling electric or other cables." A. A. VOYSEY. Dated June 26th.

10,894. "Electrometers." C. V. BOYS. Dated June 26th.

10,933. "Improvements in commutators of dynamo-electric machines." A. B. GILL. Dated June 26th.

10,934. "Improvements in dynamo-electric machinery, and in the regulation thereof." J. A. KINGDON and A. B. GILL. Dated June 26th.

10,939. "Improvements in conductors for electric lighting, electric bell circuits, and like purposes." H. A. MAVOR, W. A. COULSON, and S. MAVOR. Dated June 27th.

10,969. "Dynamo-electric machines." W. ALDRED. Dated June 27th.

10,977. "Improvements in galvanic batteries." A. DE MERITENS. Dated June 27th. [Date applied for under Patents Act, 1883, Sec. 103, 28th November, 1890, being date of application in France.]

10,978. "Improvements ininsoluble porous anodes for electrolytical processes." SIEMENS BROTHERS & Co., LIMITED. (Communicated by Siemens & Halske, Germany.) Dated June 27th.

11,004. "Improvements in and relating to the manufacture of plates for electric accumulators." C. ROUSSEAU. Dated June 27th.

11,016. "Improvements in armatures of dynamo-electric machines and electric motors." H. L. CALLENDAR. Dated June 29th.

11,048. "Improvements in the preparation and laying of electrical mains on the Brooks system." W. C. JOHNSON and S. E. PHILLIPS. Dated June 29th.

11,060. "Improvements in thermo-electric batteries." P. GIRAUD. Dated June 30th.

11,075. "Electric meters." B. J. B. MILLS. (Communicated by H. M. Pilkington and R. S. White, United States.) Dated June 30th.

11,082. "An improved telephone combination." Sir C. S. FORBES. Dated June 30th.

11,108. "Improvements in and connected with electric primary batteries." T. COAD. Dated June 30th.

11,113. "Improvements relating to electromotors, and to the transformation and distribution of electric currents." F. W. LAHMEYER. Dated June 30th.

11,118. "Improvements in electrical signals for steam vessels and analogous purposes." A. M. CLARK. (Communicated by E. W. Tucker and L. Katzenstein, United States.) Dated June 30th. (*Complete.*)

11,120. "Improved leading-in wires or conductors for incandescent electric lamps and the like." R. A. FESSENDEN. Dated June 30th. [Date aplied for under Patents Act, 1883, Sec. 103, 18th February, 1891, being date of application in United States.]

11,133. "Improvements relating to dynamo-electric machines, and electric motors, and to apparatus connected therewith." H. H. LAKE. (Communicated by The Crocker-Wheeler Electric Motor Company, United States.) Dated June 30th. (*Complete*).

11,134. "Improvements in apparatus for the electrolysis of aluminium." C. A. FAURE. Dated June 30th.

11,144. "Improvements in printing telegraphs." H. VAN HOEVENBERGH. Dated June 30th.

11,145. "Improvements in and connected with printing telegraph instruments." D. H. BATES and H. VAN HOEVENBERG. Dated June 30th. (*Complete.*)

11,149. "A multiple filament electric incandescent lamp." E. GUITTON. (Communicated by A. Collet, France) Dated June 30th.

11,157. "Improvements in transmitters and receivers for telephones." J. RADCLIFFE and J. E. SPAGNOLETTI. Dated July 1st.

11,181. "Improvements in electric switches." H. A. MAVOR, W. A. COULSON, S. MAVOR, and W. B. SAYERS. Dated July 1st.

11,201. "Improvements in apparatus for telephonic communication." J. SACK, E. VON MALTITZ, and P. ZIESEL. Dated July 1st. (*Complete.*)

11,211. "Improvements in interrupters for strong electric currents." M. KALLMAN and THE COMPANY "ALLGEMEINE ELEKTRICITATS GESELLSCHAFT." Dated July 1st.

11,225. "The improvement of production of electricity by means of a dry coil battery." F. J. REBMAN. Dated July 2nd.

11,278. "Improvements in the production of elements for electric or secondary batteries." E. HANCOCK and A. J. MARQUAND. Dated July 2nd.

11,294. "An improved system of telephonic exchange signalling." A. R. BENNETT. Dated July 3rd.

11,301. "Improvements in or relating to driving electric current generators for lighting steamships and railway trains, and for other purposes, and in apparatus therefor." P. R. DE FAUCHEUX D'HUMY. Dated July 3rd.

11,313. "Improvements in means or apparatus for utilising electrical energy in operating rock boring and other mechanism." R. BOLTON. Dated July 3rd.

11,407. "An improved thermo-electric meter." F. W. CANNON. Dated July 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

6,392. "Improvements in safety fuses for electric currents." O. T. BLATHY. Dated April 26th. 6d. The inventor passes the fuse wire or strip through holes of one or more discs or plates of insulating material, these holes being just large enough for the passage of the fuse wire or strip. 2 claims.

20,424. "Improvement in alternating current motors." M. VON DOLIVO-DOBROWOLSKY and the company "ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT." Dated December 15th. 6d. Consists in the particular arrangement and combination, with the motor, of the conductors serving to receive the operating currents, and its purpose is to simplify the motor, to impart to it greater stability, to enhance the security of its keeping in working order, and to increase its useful effect. 1 claim.

20,510. "Improvements in percussive apparatus, chiefly designed for reducing the burr on electrically-welded metal articles." H. H. LAKE. (Communicated from abroad by W. M. Wood, of America.) Dated December 16th. 8d. Consists in the novel combination of two reciprocating pistons, which may act as the valve movement for controlling the fluid pressure upon the pistons or plungers carrying the tools, or may be used for actuating a tool directly. 17 claims.

CORRESPONDENCE.

The Current Controversy.

I see that you take note in one of your leaders of 10th inst. of the controversy which has lately been carried on between Prof. S. P. Thompson and Mr. J. T. Sprague. It seems to me that the principal stumbling block appears to be that the fact that all statical phenomena consist, in reality, solely of various conditions of strain in a dielectric, does not appear to be clearly recognised. I contend that, taking this into consideration, and showing the exact relationship between displacement currents and conduction currents in the light of modern theory, it is a matter of easy proof that the energy is transmitted *viâ* the dielectric. Hoping you will kindly find room for the insertion of this.

J. E. Taylor.

July 11th, 1891.

Quadrant Electrometers.

Referring to the paper on "Quadrant Electrometers" by Profs. Ayrton and Perry and Dr. Sumpner in your issue of June 12th, we beg to state that we have lately turned our attention to the quadrant electrometer, and have been trying, under the guidance of Sir William Thomson, to simplify its parts and adjustments as much as possible. We have been led to do this mainly from the consideration that Sir William Thomson has provided, in his series of direct reading multicellular and other electrostatic voltmeters, a much more convenient and less costly means of measuring potentials above 40 volts, whether on direct or alternating circuits, than can be obtained by the *idiostatic* use of the quadrant electrometer. Our desire has been to recommend the use of these later direct-reading instruments for all measurements of potential above 40 volts, and to reserve the quadrant electrometer mainly, as hitherto used *heterostatically*, with the jar kept at a constant potential by the replenisher, for the measurement of small differences of potential in the determination of capacities, insulation resistances, &c. In these uses of the instrument the objections mentioned in the paper do not in any way interfere with its accuracy or convenience. As Professor Ayrton and his colleagues have pointed out that the action of the supports of the lower part of the guard tube would interfere with the use of the instrument for certain purposes, we have, acting under Sir William Thomson's advice, arranged to dispense with these supports and the lower part of the tube altogether. As regards the system of magnetic control mentioned in the paper, a great deal of time was spent upon this by Sir William Thomson in some of the early forms of the instrument, but the system was abandoned, as it was found inconvenient in many respects. We have, therefore, always adhered to the present bifiler system of control, which is very convenient for all degrees of sensibility, is particularly well adapted for the higher degrees of sensibility, and is perfectly free from all disturbances from magnets or any other influences external to the instrument.

James White,
Per A. W. M.

Glasgow, *July 12th*, 1891.